DIGITAL APPROACHES TO TROUBADOUR SONG

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December 13, 2019

For Grandmama

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I undertook two major archival research trips over the course of writing this dissertation. In 2013, I received funding through the A. Peter Brown Travel Fund to conduct my initial

manuscript research, during which I worked with troubadour sources at the Biblioteca Ambrosiana in Milan, the Biblioteca Marciana in Venice, the Biblioteca Riccardiana in Florence, and the Bibliothèque nationale de France in Paris. During a second archival trip in 2017, I received support from the American Musicological Society through their M. Elizabeth C. Bartlet Travel Grant; this permitted me to work with sources as the Biblioteca Ambrosiana, two different divisions of the Bibliothèque nationale de France in Paris, and the Biblioteca de Catalunya in Barcelona. I would also like to thank Ilaria Zamuner for her generosity in discussing my project during my first archival trip in 2013. I am very grateful to the staff of the archives I visited both for their assistance during my time at their institutions as well as in procuring images of manuscripts. I particularly wish to thank Friedrich Simader and Ingeborg Formann at the Österreichische Nationalbibliothek in Vienna for their assistance with obtaining images of the melodies in two manuscripts, *Eug* and *Hoh*, as neither manuscript is available for direct consult because of their current states of conservation.

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and Daniel Story. I would also like to acknowledge the essential support I received through technical training offered by IDAH, the IU Scholar's Commons, IT Training, and Research Technologies while at IU. These organizations provided both training and consultations in the planning stages of the project as I learned to use new software and drafted plans for the database, as well as helping refine the project in later stages. In particular, I am deeply grateful for the support of members of the Cyberinfrastructure for Digital Humanities and Creative Activities, with whom I have had the privilege of working during the last few years. They, along with other staff in Research Technologies, have been enormously supportive as I finished this dissertation. Tassie Gniady has been a constant source of support for my project, including connecting me with the consultants who assisted me with the additions to the Melody Search Tool, Adam Hochstetter and Guangchen Ruan. David Kloster provided support for the text analysis components of my dissertation, particularly for the Python script I use for Latent Semantic Analysis (LSA). I would also like to acknowledge the Indiana University Pervasive Technology Institute for providing HPC (Carbonate) resources that contributed to the results reported within this project. This research was thus also supported in part by Lilly Endowment, Inc., through its support for the Indiana University Pervasive Technology Institute.

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Katie Elizabeth Chapman

DIGITAL APPROACHES TO TROUBADOUR SONG

The troubadours were poet-composers who flourished in Occitania (today southern France) and surrounding areas during the twelfth and thirteenth centuries. Their lyric poems survive in *chansonniers* (songbooks) which usually contain only the texts. A fraction of the melodies that accompanied these poems were written down; fewer than 350 melodies survive for a lyric corpus of over 2,600 songs which appear over 13,000 times in all extant sources.

This dissertation is part of a larger project whose aim is twofold: to create an open-access, electronic, searchable archive of these melodies and to apply computational methods of analysis to identify the musical characteristics of the melodies, find patterns and relationships, and track trends in style both over time and within the works of individual authors.

In this study, I first illustrate the methodology I followed to assess and encode the corpus of troubadour melodies and give an overview of the types of tools used to analyze the encoded melodies. In the subsequent chapters, I present five case studies which investigate musical features of the repertory through computational and statistical approaches, where I confirm, revise, or expand on existing knowledge of the repertory. The first case study identifies the extent and features of Guiraut Riquier's melismatic writing by applying analytical techniques typically used to analyze textual corpora. The second case study applies a different technique borrowed from computational linguistics, Latent Semantic Analysis (LSA), to track the similarity of melodies with versions extant in multiple sources and to compare the phrases of melodies in one manuscript which have notation for more than one stanza. The three case studies in Chapter III adopt other analytical approaches to investigate and compare the pitch and interval

content of the melodies. These studies help identify patterns in pitch organization in the entire repertory, point out stylistic trends of specific troubadours, and compare selected musical features by source. Overall, this study demonstrates the possibilities of computational approaches to contribute to existing scholarship on this repertory. Furthermore, the digital archive created for this project aims to empower additional research on the music of the troubadours, including the study of corpus-wide characteristics, the analysis of stylistic traits in specific authors or sources, and changes in style over the course of the tradition.

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Elizabeth K. Hebbard, Ph.D.

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List of Musical Examples

Manuscript Sigla

Shelfmark	Siglum	Name or Work Title
Barcelona, Biblioteca de Catalunya, 3871	*SJA*	*Sant Joan de les Abadesses*
Cividale del Friuli, Museo Archeologico Nazionale, 1484	*Civ*	
El Escorial, Biblioteca del Monasterio, S.I.3	*Esc*	*Breviari d'Amor M*
Madrid, Biblioteca Nacional, 105	*Mad*	
Milan, Biblioteca Ambrosiana, D 465 infra	*Fb* (*TrouvXa*)	
Milan, Biblioteca Ambrosiana, R 71 sup.	*G*	
Montpellier, Bibliothèque Universitaire Historique de Médecine, H196	*Mo196*	
Montpellier, Médiathèque centrale Emile Zola, 120	*Mo120*	
Paris, Bibliothèque de l'Arsenal, 5198	*TrouvK*	*Chansonnier de Navarre*
Paris, Bibliothèque de l'Arsenal, 6361	*Ars*	
Paris, Bibliothèque nationale de France, fr. 844	*W*	*Manuscrit du Roi*
Paris, Bibliothèque nationale de France, fr. 845	*TrouvN*	
Paris, Bibliothèque nationale de France, fr. 846	*Cangé (TrouvO)*	*Chansonnier Cangé*
Paris, Bibliothèque nationale de France, fr. 856	*C*	
Paris, Bibliothèque nationale de France, fr. 1749	*E*	
Paris, Bibliothèque nationale de France, fr. 12615	*Delta (δ)*	*Chansonnier dit de Noailles*
Paris, Bibliothèque nationale de France, fr. 20050	*X*	*St. Germaine des Prés*
Paris, Bibliothèque nationale de France, fr. 22543	*R*	*Chansonnier La Vallière*
Paris, Bibliothèque nationale de France, fr. 24406	*LaVal/n (TrouvV)*	
Paris, Bibliothèque nationale de France, fr. 25532	*CdP*	*Court de Paradis*
Paris, Bibliothèque nationale de France, lat. 1139	*Lat1139*	
Paris, Bibliothèque nationale de France, naf. 1050	*TrouvX*	*Chansonnier Clairambault*
Paris, Bibliothèque nationale de France, naf. 13521	*Naf*	
Rome, Biblioteca Apostolica Vaticana, Chigi C.V. 151	*Chig*	*Play of Saint Agnes*
Saint Petersburg, Biblioteca publica, fr. F.v.XIV.1	*Len*	*Breviari d'Amor N*
Vatican City, Biblioteca Apostolica Vaticana Reginae lat. 1659	*η (eta)*	*L'estoire de la guerre saint*
Venice, Biblioteca Nazionale Marciana fr. App. Cod. XI=278	*V*	
Vienna, Österreichische Nationalbibliothek, 2563	*Eug*	*Breviari d'Amor F*
Vienna, Österreichische Nationalbibliothek, 2583	*Hoh*	*Breviari d'Amor G*
Wolfenbüttel, Herzog August Bibliothek, Helmst. 1099	*W2*	

Introduction

This study builds on generations of scholarship on the troubadours, their sources, and their poetic and musical style to contribute to a better understanding of the legacy of these poet-composers, who flourished in Occitania (today southern France) and surrounding areas during the twelfth and thirteenth centuries. The chapters that follow are the prose component of a larger project whose aim is twofold: to create an open-access, electronic, searchable archive of the melodies and to apply computational methods of analysis to the melodic repertory. Computer-based analysis of the remaining evidence for troubadour melodies allows larger-scale scrutiny, permitting what Franco Moretti describes as "distant reading."[1] Although the troubadour musical repertory is much smaller than the datasets used in Moretti's studies of the novel in nineteenth-century Britain, a searchable archive of troubadour melodies encoded for this project enables analysis which confirms, adjusts, or revises our existing knowledge of the repertory while empowering future research. The archive and tools developed for this project are available in the Troubadour Melodies Database (TMD, available online at www.troubadourmelodies.org); parts of these digital resources are reproduced in the dissertation. Although this is not the first project to apply quantitative or digital methods to this repertory, it does so more broadly than previous studies through its encoding of the entire repertory, the scope of its analysis, and its availability as a public-facing resource.

[1] Franco Moretti, *Distant Reading* (London: Verso, 2013), 6. Franco Moretti, one of the leading figures of this field, describes the difference between close reading, the more traditional in-depth study of individual texts, and distant reading, the statistical analysis of a large body of works to generate the features of the corpus such as word frequency, co-occurrence, or other patterns across hundreds, or even thousands or tens of thousands of texts, with respect to many of his projects, such as his work in connection with the study of "the great unread." *Distant Reading*, 45-46 and 87-89.

The troubadours composed lyric and prose works in Old Occitan and constitute one of several traditions of vernacular secular monophonic song in the medieval period. Their songs survive primarily in songbooks (chansonniers) which most often preserve only the texts of songs. However, a small percentage of the melodies that accompanied these texts remain. For a lyric corpus comprising over 2,600 cataloged works in almost 13,000 appearances, only 264 songs have been preserved with at least one melody (including both unica and concordances, there are 342 melodies extant).[2] In addition to the melodies themselves, a few sources contain empty staves and space for staves never entered; this indicates planning for musical copying that was never completed.[3]

Works attributed to over 460 troubadours are extant today. Some troubadours have a large number of surviving songs while others have only a few; some are known only through references in works by other troubadours. In addition to the lyric corpus, there is a smaller group of prose works by troubadours. There are also bibliographic *vidas* and explanatory *razos* in some sources.[4] The troubadours were active for over two centuries, from the earliest, Guillaume IX, Count of Poitiers, in the late eleventh century (1071-1126), through Guiraut Riquier, considered the last of the troubadours, who flourished c.1254-1292. Musicologist Elizabeth Aubrey

[2] For a recent overview of the extent and sources of the troubadour repertory, see Elizabeth K. Hebbard, "Manuscripts and the Making of the Troubadour Lyric Tradition" (PhD diss., Yale University, 2017). The repertory in the TMD is outlined in Chapter I.

[3] A list of all manuscripts referenced in the dissertation is included in the front matter. A complete list of all sources included in digital tools or analysis is available in the TMD.

[4] The *vidas* appear in twenty-three troubadour manuscripts and fragments, including the primary musical source for troubadour song, *R*. The manuscripts with *vidas* were made from the late thirteenth century through the eighteenth; sixteen of these are medieval sources (made prior to 1400). The *vidas* were thus written down c.150 years after the death of the first troubadour, Guilhem IX de Poitiers, and nearly contemporaneously for later troubadours, such as Peire Cardenal, Lanfranc Cigala, and Sordel. For an edition of the *vidas*, see Jean Boutiére, A. H. Schutz, and I. M. Cluzel, *Biographies des troubadours: Textes provençaux des XIIIe et XIVe siècles*, 2nd ed. (New York: Burt Franklin, 1972); for English translations, see Margarita Egan, ed. and trans. *The Vidas of the Troubadours* (New York: Garland, 1984). For an edition of the *razos*, explanatory stories provided for some songs, see William E. Burgwinkle, *Razos and Troubadour Songs* (New York: Garland, 1990).

organizes the forty-seven troubadours with extant melodies into six generations based on their known periods of activity for her research.[5]

Within troubadour lyric, genres are distinguished by the topics and (in some cases) the poetic forms of the texts. Two medieval discussions of genre and their position within the troubadour corpus are Guilhem Molinier's (fl.1330-1350) *Las Leys d'Amor*, a treatise on grammar and rhetoric,[6] and *De musica*, written c.1300 by music theorist Johannes de Grocheio.[7] The lyric repertory of the troubadours is dominated by one genre, the *canso* (love song).[8] The next most frequent genres are the *sirventes* (moralizing or satirical song) and *cobla* (a stanza of song, appearing on its own or as part of an exchange).[9] In the melodic tradition, the *canso* makes up almost eighty percent of the repertory; the next most common genre transmitted with a melody is the *vers* (a general term for poems). The numbers then drop rapidly for the *sirventes*, *planh* (lament), and *dansa* (dance with refrain), which each make up about two percent of the total number of songs with melodies.[10] Figure I.1 represents the division of the surviving melodic

[5] Elizabeth Aubrey, *The Music of the Troubadours* (Bloomington: Indiana University Press, 1996). See Appendix A for a list of troubadours with extant melodies.
[6] For an edition of the treatise, see Guilhem Molinier, *Les leys d'amors; manuscrit de l'Academie des jeuxfloraux*, ed. Joseph Anglade. 4 vols. (Toulouse: Privat, 1919-1920). For more recent discussions of genre, see Willam Paden, "System of Genres in Troubadour Lyric," in *Medieval Lyric*, ed. William Paden, 21-67 (Urbana: University of Illinois Press, 2000), and Billee Bonse, "'Singing to Another Tune': Contrafacture and Attribution in Troubadour Song" (PhD diss., The Ohio State University, 2003), 18-21. The primary modern catalogues which assign genres to troubadour songs are István Frank's *Répertoire métrique de la poésie des troubadours* and Pillet and Carstens's *Bibliographie der Troubadours*.[6] See István Frank, *Répertoire métrique de la poésie des troubadours* (Paris: Champion, 1953-57) and Alfred Pillet, *Bibliographie der Troubadours*, supplements by Henry Carstens (Halle: M. Niemeyer, 1933). An updated edition of Pillet and Carstens appeared in 2013.
[7] For an edition and translation of Grocheio's treatise regarding secular music, see Christopher Page, "Johannes de Grocheio on Secular Music: A Corrected Text and New Translation," *Plainsong and Medieval Music* 2, no. 1 (April 1993): 17-42.
[8] Paden, "Systems of Genres," 27.
[9] Paden, "Systems of Genres," 27.
[10] A glossary of genres and other relevant terminology can be found in Aubrey, *Music of the Troubadours*, ix-xi, and in Simon Gaunt and Sarah Kay, eds., *The Troubadours: An Introduction* (New York: Cambridge University Press, 1999), Appendix 2, 292-294.

corpus by genre (genres representing less than one percent of the corpus are not given labels in the chart itself):[11]

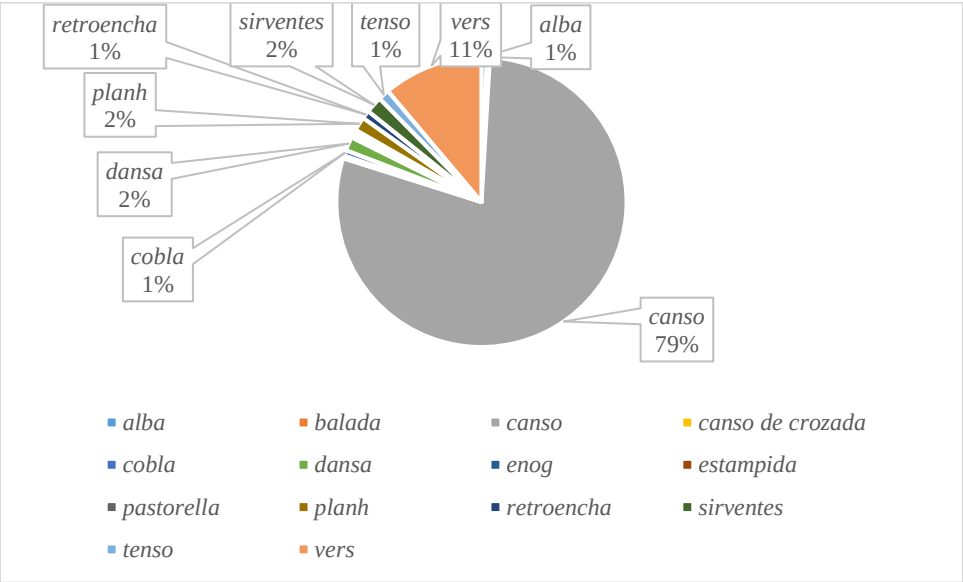

Figure I.1: Extant melodies by genre

The surviving troubadour manuscripts include chansonniers, planned collections of troubadour songs that sometimes include trouvère lyric or other works in Occitan, and non-chansonnier manuscripts and fragments containing a small number of works. The text-only chansonniers share many characteristics with the musical manuscripts, including similar styles of decoration and approaches to organization. Only two troubadour chansonniers are notated (*G* and *R*); one other troubadour chansonnier, *V*, was planned for musical transmission but never notated. Two trouvère sources (*W* and *X*) contain a troubadour section with melodies. In addition

[11] See discussions of Grocheio and of the relationship between genre and melody more generally in Aubrey, *Music of the Troubadours*, "Poetics and Music," 66-79, and her chapter "Genre as a Determinant of Melody," in *Medieval Lyric*, ed. William Paden, 273-296 (Urbana: University of Illinois Press, 2000). Also see Robert Mullaly, "Johannes de Grocheio's 'Musica Vulgaris'," *Music & Letters* 79, no. 1 (February 1998): 1-26.

to these five main music sources, fourteen others include a small number of troubadour songs (either notated or planned for notation) within a larger collection of trouvère song or in a non-chansonnier.[12]

The troubadour chansonniers (both text-only and music) display common organizational principles. The two major factors in organization appear to have been genre and authorship. The chansonniers usually exhibit overarching structures based on genre, typically divided into macro sections for *cansos*, *coblas*, *tensos*, and *sirventes*, within which works are organized by author.[13] These divisions, while not absolute, are reflected in many of the surviving sources. Additionally, several sources contain a section called *florilegium* with excerpts, often single stanzas (*coblas*), from larger songs.

The notation used to write down the troubadour melodies includes several varieties of neumatic notation, reflecting different regional practices and changes over time. In addition to quadratic notation, which appears in the majority of sources, several other types appear as well. Mensural notation is used for troubadour songs in *Cangé* and part of *W*; the same is true of a small number of melodies in *R*.[14] In *Chig*, there are some cases where the placement of caudae or the arrangement of note heads could suggest the scribe had ligature propriety or other aspects of pre-Franconian notation in mind, but there is not a consistent application of those characteristics

[12] A thorough review of the musical sources can be found in Hebbard, "Manuscripts," as part of her updated catalog of sources in Appendix A.
[13] See William Burgwinkle, "The *Chansonniers* as Books," in *The Troubadours: An Introduction*, ed. Simon Gaunt and Sarah Kay, 246-262 (New York: Cambridge University Press, 1999), 260, n.11 and 247-238. *R*'s organization does not fit into a large overall structure of the major genres, instead having several sections of each type of genre. For a thorough discussion of *R*'s organization, see Aubrey, "A Study of the Origins, History, and Notation of the Troubadour Chansonnier Paris, Bibliothèque Nationale, f. fr. 22543" (PhD diss., University of Maryland, 1982).
[14] The mensural notation in these cases is not always complete in its representation, leaving the rhythms difficult or impossible to transcribe.

throughout the manuscript.[15] *X* is the only source with melodies notated in Messine neumes, also sometimes referred to as Lorraine, Metz, or Laon notation.[16] The notation in *SJA*, a fragment containing four troubadour songs found at the convent Sant Joan de la Abadesses (province of Girona, Spain), has traditionally been identified as Messine.[17] However, based on its differences from Messine notation and its similarities to Aquitanian neumes found in thirteenth-century chant books from Southern France and Catalonia, I reclassify it as Aquitanian. This form of notation also aligns with the geographical origins of the manuscript and language of the texts, since Aquitanian neumes were used in both Occitania and the Iberian Peninsula.[18] This reclassification increases the number of sources with Old Occitan texts notated with Aquitanian neumes from one (*Lat1139*) to two; the two sources are separated by almost two hundred years (from the early twelfth century through the late thirteenth).This is particularly significant because *SJA* provides the only known examples of secular lyric in Old Occitan with melodies notated in Aquitanian notation, as the three melodies in *Lat1139* appear with sacred texts.

[15] The manuscript and work have recently been the subject of research by Veronica Maria da Rosa Guimaraes for her master's thesis: "Hidden Meanings: Troubadour Contrafacta in the Provencal Drama 'Tragedia de Sancta Agnetis'" (MA thesis, University of Connecticut, 2015).

[16] As noted by Hélène Beguermont, the name was applied to the notation in 1892 by Dom Mocquereau (of the *Paléographie musicale* project) but it has since been proven a misnomer as no manuscripts from Metz are extant that use this notation in the first centuries of its appearance. Hélène Beguermont, *La première écriture musicale du monde occidental: La notation neumatique dans les manuscrits de chant grégorien du IXème au XIIIème siècle* (Bourg-la-Reine: Zurfluh, 2003), 129.

[17] When this fragment was first described by Higini Anglés in 1935, he described the notation as Messine, the same type of notation found in *X*. Higini Anglés, *La Musica a Catalunya fins al segle XIII* (Barcelona: Institut d'estudis catalans: Biblioteca de Catalunya, 1935), 182-184. More recently, musicologist Maricarmen Gómez Muntané drew attention to the clear differences between the notation found in the fragment and characteristic Messine notation, suggesting that, as a notary, the scribe was probably unfamiliar with musical notation and had recreated in these fragments a more cursive, even sketch-like, version of Messine notation he saw in an exemplar. She does note that it is somewhat surprising the scribe, working in Catalonia, would have knowledge of Messine notation, rather than the Catalonian or Aquitania notation systems used locally. Isabel de Riquier and Maricarmen Gómez Muntané, *Las canciones de Sant Joan de les Abadesses*, 33-4; 36-7.

[18] In her work on the fragment, Maria Sofia Lannutti concludes that the base language of the songs in the fragment is Occitan-Catalan showing Italian influences. Maria Sofia Lannutti, "L'ultimo canto: musica e poesia nella lirica catalana del medioevo (con una nuova edizione del Cançoneret di Sant Joan de les Abadesses)," *Romance Philology* 66, no. 2 (Fall 2012): 314.

A Short Review of Scholarship

Troubadour scholarship is a vast field spanning many disciplines. Similarly to William Burgwinkle in his chapter "The *Chansonniers* as Books," this project considers the surviving troubadour chansonniers and their contents while stressing their individuality and vitality as both sources and objects.[19] Burgwinkle's focus on the manuscripts as individual entities influenced my perspective on manuscripts as objects which participate within networks of transmission.[20] A general overview of the main musical sources can be found in Aubrey's monograph *The Music of the Troubadours,* including features of their particular notation and contents throughout the book.[21]

Most recently, Elizabeth K. Hebbard contributed a new catalog of troubadour manuscripts, including detailed descriptions and, where needed, updated information on their date and place of origin.[22] Her work identifies the largest number of troubadour manuscripts known to date, adding significantly to our knowledge of the surviving evidence of troubadour lyric and melody; her study also stresses the importance of the inclusion of all sources of troubadour song in the group of sources studied, a position echoed in my work. Hebbard's dissertation provides the most recent and comprehensive discussion of the troubadour musical sources, including an overview of the manuscripts as well as providing details on individual sources and the relation of the musical sources to the broader troubadour manuscript tradition.[23] A recent study which places the troubadour sources within the larger context of songbooks in the

[19] Burgwinkle, "The *Chansonniers* as Books."
[20] Hebbard also frames her discussion of transmission within networks of lyric song in her discussion of melody. Hebbard, "Manuscripts," 125.
[21] Aubrey, *Music of the Troubadours*.
[22] Hebbard, "Manuscripts," Appendix A, 182-431.
[23] See Hebbard, "Manuscripts," Chapter 4, 124-177.

medieval period is literary scholar Marisa Galvez's *Songbook: How Lyrics Became Poetry in Medieval Europe*, which incorporates both troubadour and trouvère chansonniers into her study of the representation and reception of lyric and the impact of songbooks on modern understandings of the nature of poetry.[24] Her work examines the conceptualization, planning, and structure of the chansonniers in their original context, as well as the ways in which they have been perceived and explained by scholars. Galvez also provides context and insight into organization, attribution, and naming within the sources. Hebbard engages with both similar concepts and with Galvez herself in her dissertation, which reconsiders the meaning of attribution in the manuscripts, both for texts and melodies.[25]

Many studies focus on individual chansonniers; a recent and significant endeavor is the ongoing *Intavulare* series, which aims to not only publish updated lists of the manuscripts' contents, but also provides fresh studies of each of the chansonniers.[26] The volumes in the series thus provide essential and current information on the origins, dating, physical features, and contents of the manuscripts. Musicologists have also investigated the codicological, paleographic, and notational aspects of the manuscripts, typically with a focus on the sources with notation; the most significant of these for the case studies are reviewed below.

Studies of the first chansonnier with a significant collection of troubadour songs, *X*, include a facsimile and study by Paul Meyer and Gaston Raynaud in 1892 as well as more recent work by Madeleine Tyssens which include a general study of the manuscript, research on its

[24] Marisa Galvez, *Songbook: How Lyrics Became Poetry in Medieval Europe* (Chicago: University of Chicago Press, 2012).
[25] Hebbard, "Manuscripts," particularly Chapters 3 and 4, which examine attribution in rubrics and with respect to both texts and melodies.
[26] There are multiple branches to the series, each focused on a different primary language (Occitan, French, Italian, and Catalan) each with their own editors. For a review of the *Intavulare* series, see William Paden, "Beginning: Table of Romance Songbooks," *Romance Philology* 61 (March 2007): 79-92 (particularly 82-85).

compilation and copyists, and an edition of its texts.[27] Hebbard provides a description of this source in her catalog in addition to extensive discussion of *X* with respect to its contents, melodic significance, and lack of attribution; her study also evaluates linguistic features of the songs within the context of the place of hybrid French-Occitan texts in the troubadour canon.[28] From her analysis of *X*, she concludes that northern reception of troubadour songs was influenced by melody rather than the status of specific troubadours.[29]

The contents, notation, structure, and physical features of *W* have been studied fairly recently by both Judith Peraino and John Haines. Peraino's dissertation evaluates *W* with respect to its copying and compilation, including a focus on the contents and features of the planned anthology of works compared to the characteristics of its numerous additions, for both text and melody.[30] Her work thus contributes a comprehensive discussion of the scribal hands in *W*, along with clear identification and description of each of the additions in the source. Haines's "The Musicography of the *Manuscrit du Roi*" provides a systematic analysis of the notation of that source as well as its history and compilation; his later article provides a detailed history of the manuscript.[31] He engages with Peraino's discussion of the additions to *W* in his dissertation, proposing several revisions to her assessments of scribal hands.[32]

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[27] Paul Meyer and Gaston Raynaud, eds., *Le Chansonnier français de Saint-Germain-des-Près (BN fr. 20050), Société des anciens texts français* (Paris: Didot, 1892); Madeleine Tyssens, *Le Chansonnier français U publie d 'apres le ms. Paris, BnF.f, 20050* (Abbeville: Societe des Anciens Textes Français, 2015); Madeleine Tyssens, "Les copistes du chansonnier français *U*," in *La Lyrique romane medievale: La tradition des chansonniers*, Actes du Colloque de Liege, 379-398. Tyssens also edited the *Intavulare* volume for *X* (Series II, vol. 5). A project to publish a new edition of the melodies in *X* is in-progress by Robert Lug.
[28] Hebbard, "Manuscripts," 147-156.
[29] Hebbard, "Manuscripts," 156.
[30] Judith Peraino, "New Music Notions of Genre, and the 'Manuscrit du Roi; circa 1300" (PhD diss., University of California at Berkeley, 1990).
[31] John Haines, "The Musicography of the *Manuscrit du Roi*" (PhD diss., University of Toronto, 2002) and "The Transformation of the *Manuscrit du roi*," *Musica Disciplina* 52 (1998-2000): 5-43.
[32] Haines, "The Musicography of the *Manuscrit du Roi*," 162-165.

Aubrey's detailed study of *R* surveys its compilation, notation, hands, and other features, providing essential information about the source and its contents.[33] Her article "The Transmission of Troubadour Melodies: The Testimony of Paris, Bibliothèque nationale, f. fr. 22543" concludes that *R*'s copying involved a variety of sources compiled by a number of scribes; she also determines the texts and music were copied from different exemplars based on notational features and differences in the musical and textual planning of the source.[34] She further places *R* within the context of the other sources throughout her monograph, addressing similarities and differences between the sources in terms of their features, history, and contents, including detailed discussion of several melodies.[35]

Ugo Sesini's facsimile, study, and edition of *G* is valuable not only in its discussion of the manuscript, but also in its (now historical) facsimiles of the melodies. Francesco Carapezza updates and revises Sesini's work in his two published volumes on *G*: one is an extensive study of the manuscript and the other is a shorter version of that study which appears as part of the *Intavulare* series discussed above.[36] His significant contribution updates both the dating and place of origin for *G*, placing it earlier and in the Veneto instead of Lombardy. The longer study provides the clearest representation of the source currently available through its inclusion of a

[33] Aubrey, "A Study of the Origins." Part of her dissertation was published in an article on transmission: "The Transmission of Troubadour Melodies: The Testimony of Paris, Bibliothèque nationale, f. fr. 22543," *Text* (1987): 211-250.
[34] Aubrey, "Transmission of Troubadour Melodies," 225-229.
[35] Aubrey, *Music of the Troubadours*.
[36] Francesco Carapezza, *Il canzoniere occitano G (Ambrosiano R 71 sup.)* (Naples: Liguori Editore, 2004) and *Milano, Biblioteca ambrosiana G (R 71 sup.). Intavulare: Tavole di canzonieri romanzi*. I. Canzonieri provenzali, 6, ed. Anna Ferrari (Modena: Mucchi Editore, 2004).

complete diplomatic transcription of the manuscript (images of the musical notation are provided rather than transcriptions).[37]

The circulation of the repertory, including the roles of oral and written transmission, is of paramount importance to our understanding of why and when the melodies were notated in the sources. This includes consideration of both the possible perspective of authors and the certain interventions of scribes. Each of these factor into modern understanding of the relationship between the melodies as they appear in the surviving sources to how they were heard in medieval performance. Scholarship on this area thus contributes to my belief in the importance of studying all melodies as they appear in their sources, as well as considering how the melodies may have reached us in the forms (and limited numbers) they have. My discussion of the intended and actual transmission of troubadour melody (the transmission of not only notated melodies, but also songs with evidence of musical planning) draws on recent studies of the troubadour sources to ensure I have included all possible sources of troubadour song and the most current information on those manuscripts in my analysis and discussion.[38]

Transmission is a major topic of discussion for troubadour song which is addressed by many scholars; some of the most significant includes work by Aubrey, who provides details about the copying of particular sources in her discussion of the manuscripts in her monograph as well as an earlier article on transmission and scribal practice in *R*, discussed above.[39] She returns to this topic in her article "Literacy and Orality," which investigates the intended functions of the

[37] Ugo Sesini, *Le melodie trobadoriche nel canzoniere provenzale della Biblioteca Ambrosiana R.71 sup.* (Turin: G. Chiantore, 1942); Francesco Carapezza, *Il canzoniere occitano G (Ambrosiano R 71 sup.)* (Naples: Liguori Editore, 2004). Also see the most recent catalog and description of *G* in Hebbard, "Manuscripts," 247-248.
[38] Hebbard's new catalogue, though appearing after the encoding of the corpus, was an excellent resource with which compare my corpus and update it where possible. See Hebbard, "Manuscripts," Appendix A.
[39] Aubrey, "The Transmission of Troubadour Melodies."

chansonniers, evidence for oral or written transmission of melodies, and the question of musical literacy among the troubadours, their audience, and patrons.[40] Aubrey's work concludes that the written tradition for troubadour melodies began in Northern France while the repertory itself remained primarily oral; the earlier interest in written transmission of melodies in Northern France thus also influenced the higher rate of survival of trouvère melodies compared to those of the troubadours.[41] Van der Werf addresses the role of scribes in the versions of melodies found in the sources, including issues of erasure, modifications to both text and melody, and other interventions in his work on the melodies.[42] Hebbard also discusses the active, rather than passive, role of scribes in manuscript copying and compilation, as well as their role in variations that appear during copying.[43]

With respect to authorial intervention in troubadour song, Chantal Phan has published on Guiraut Riquier's role in the transmission of his works and possible impacts of his intervention on his works both musically and textually, such as their melismatic style; she thus counters Van der Werf's claim that, based on the missing melodies for many of his works in *R*, as well as omitted text in some songs, neither the texts or melodies were from a book from Riquier's own hand.[44] She further determined that Riquier used melismas as essential features of his melodies.[45] Olivia Holmes has also contributed to the body of scholarship on Riquier's authorial role in his works within the larger context of her research on authorship in books of lyric and poetry from

[40] Aubrey, *Music of the Troubadours*, 34-49; Elizabeth Aubrey, "Literacy, Orality, and the Preservation of French and Occitan Medieval Courtly Songs," *Revista de musicologia* 16, no. 4 (1993): 2355-2366.
Also see her dissertation, discussed previously. Aubrey, "A Study of the Origins."
[41] Aubrey, "Literacy and Orality," 11.
[42] Hendrik Van der Werf, *The Extant Troubadour Melodies: Transcriptions and Essays* (Rochester, NY: Hendrik Van der Werf, 1984), 34-38.
[43] Hebbard, "Manuscripts," 31 and 38-39.
[44] Chantal Phan, "Structures poético-musicales du chant mélismatique chez Guiraut Riquier et Alphonse le Sage," *Tenso* 11, no. 2 (Spring 1996): 163-178, and "Le style poético-musical de Guiraut Riquier," *Romania* 108, no. 429 (1987): 66-78. See Van der Werf, *Extant Troubadour Melodies*, 28.
[45] Phan, "Structures poético-musicales" and "Le style poético-musical de Guiraut Riquier."

the troubadours through Petrarch.[46] Holmes considers both manuscript evidence and the contents of Riquier's lyrics themselves to articulate Riquier's self-conception of his role as author in both the transmission and composition of his works.

Given the basis of my project in digital tools, below I provide a brief account of digital scholarship that was influential during the planning stages of the TMD and my analysis of the repertory; more detailed discussion of the technical aspects of these projects follows in Chapter I. Two of the most significant models for my project are searchable chant databases. These are the Global Chant Database (www.globalchant.org), built and maintained by Jan Koláček, and the Cantus Index (http://cantusindex.org/), a database for chant designed and directed by Deborah Lacoste and Jan Koláček.[47] Another significant project which was influential through both its structure and contents is the Bibliografia Elettronica dei Trovatori (BEdT), directed by Stefano Asperti, which brings together information about the corpus from major reference sources on the attribution, genre, structure, and, where possible, topics, and historical references to persons and places.[48]

[46] Olivia Holmes, *Assembling the Lyric Self: Authorship from Troubadour Song to Italian Poetry Book* (Minneapolis: University of Minnesota Press, 2000). Holmes includes a chapter on Riquier in her book, as well as a chapter on troubadour Uc de Saint Circ.

[47] Koláček is a PhD Candidate at the Institute of Musicology at Charles University in Prague. He has worked on several additional databases since launching the Global Chant Database in 2009, including providing both technical assistance and planning feedback in the early stages of the construction of the TMD. Both Lacoste and Bain have also provided feedback on the site. Their project, the Cantus Manuscript Database (http://cantus.uwaterloo.ca), also uses the same platform and a version of the melody search tool built by Koláček. Cantus Ultimus (https://cantus.simssa.ca/), a collaboration with Single Interface for Music Score Searching and Analysis project (SIMSSA, https://simssa.ca/), serves as an model for future projects incorporating both manuscript images and searchable transcriptions by employing Optical Music Recognition (OMR).

[48] As of August 2019, the BEdT was in its version 2.5 from 26 September 2012. See *Bibliografia Elettronica dei Trovatori*, directed by Stefano Asperti, Università degli Studi di Roma "La Sapienza," 2003 (accessed 31 May 2012), http://www.bedt.it. In this database, troubadours are assigned to six generations which mainly, though not always, overlap with those outlined by Elizabeth Aubrey. The BEdT also permits troubadours to belong to two generations, which is not the case in Aubrey's study. The site also provides information on the manuscripts' contents and information on the troubadours, *vidas*, and *razos.*

A combination of humanist and computational approaches factor into both the TMD and this dissertation, ranging from the digital resources outlined above, to the scholarship which motivated and supported this research, to the various analytical approaches utilized. While digital projects are still not very common in musicology in 2019, there have been several significant projects which rely on digital encoding and computational approaches in the field and their number is increasing. These include notable digital editions, such as the Digital Mozart-Edition[49] and the Josquin Research Project,[50] which both provide searchable versions of scores. There are also online archives such as the multi-disciplinary IDEA project (Isabella d'Este Archive)[51] and DIAMM (Digital Image Archive of Medieval Music), an archive of manuscript descriptions with images for a majority of the sources included.[52] Michael Cuthbert incorporates computational and statistical analysis of *trecento* sources and music into his research and publications, including a database of encoded scores.[53] Based on his analysis, he concludes that the surviving *trecento* sources are reflective of the total repertory and constitute a majority of what existed, rather than a minority; he further proposes that similar probability models can be used to estimate the size of lost corpora in other periods as well.[54] In addition to the accomplishments of such digital projects and research, recognition of such projects in academic journals and organizations has also increased in recent years.[55]

[49] Digital Mozart-Edition, published by the Internationale Stiftung Mozarteum, Salzburg https://mozarteum.at/en/digital-mozart-edition/ (accessed 15 November 2019).
[50] The Josquin Research Project, dir. by Jesse Rodin, https://josquin.stanford.edu/ (accessed 15 November 2019).
[51] IDEA: Isabella D'Este Archive, http://ideamusic.web.unc.edu/ (accessed 15 November 2019).
[52] Digital Image Archive of Medieval Music, https://www.diamm.ac.uk/ (accessed 15 November 2019).
[53] Michael Scott Cuthbert, "Tipping the Iceberg: Missing Italian Polyphony from the Age of the Schism," *Musica Disciplina* 54 (2009): 39-74, and Michael Scott Cuthbert and Elizabeth Nyikos, "Style, Locality, and the Trecento Gloria: New Sources and a Reexamination," *Acta Musicologica*, 82, Fasc. 2 (2010): 185-212.
[54] Cuthbert, "Tipping the Iceberg," 59.
[55] The Medieval Academy of America curates a list of digital projects on medieval topics (Medieval Digital Resources (MDR), http://mdr-maa.org/ (accessed 15 November 2019)) and offers a yearly Digital Humanities Prize. The Journal of the American Musicological Society includes reviews of digital editions and projects.

While the TMD is not the first project to encode the melodies, previous encodings preserved only a small number of musical elements from the melodies (such as interval or contour). They were also not openly available for use by other researchers, which limited the replicability of those studies. These limitations thus restricted the possibility for access to or extension of analysis for these studies and their encoded melodies. Several studies, discussed briefly below and in more technical detail in Chapter I, apply one or more computational or digital approaches to the troubadour melodies; my project differs from these in either the scope of the encoded repertory or the scope of the analysis, as many previous projects focused on a subset of the troubadour melodies or had a limited analytical output.

In his 1978 master's thesis, David Halperin analyzed intervallic patterns based on the melodies as transcribed by Friedrich Gennrich.[56] Halperin used his dataset to identify patterns in melodic incipits and cadences. His subsequent article focused on applying his analysis to the phrase structure of the melodies; he concludes that the intervallic patterns he identifies comprise the general compositional components for the melodies and outlines his hypotheses on their usage in the repertory.[57] In his 1989 dissertation, Matthew Steel utilized computational approaches to determine the number of pitches per syllable in each melody (which he terms "pitch density") as a way of evaluating the overall melismatic nature of melodies by calculating a statistical average of the number and length of melismas. [58] He also analyzed the intervallic

[56] David Halperin, "A Structural Analysis of Troubadour Song" (MA thesis, Tel Aviv University, 1978). Halperin specifies the 285 melodies used for his study in the thesis using their identifying numbers from Gennrich's edition: No. 7-33, 35-181, 183, 185-279, 287-300, 302. Friedrich Gennrich, *Der musikalische Nachlass der Troubadours*, 3 vols. (Darmdstadt: [Gennrich], 1958-1965).
[57] David Halperin, "Distributional Structure in Troubadour Song," *Orbis Musicae: Studies in Musicology* 7 (1979-80): 15-26.
[58] Matthew Steel, "Influences on the Musical Style of the Troubadours of the Twelfth and Thirteenth Century Southern France" (PhD diss., The University of Michigan, 1989).

content of the melodies, focusing on intervals a third and larger, to compare the musical style of the four main sources.

Two dissertation-length studies have focused on approaches to pitch organization in the melodies. In Chapter III, I build on these studies by analyzing evidence of pitch organization in the entire corpus rather than a subset; I then evaluate the previous two studies to verify their perspectives on the extent to which mode and other analytical approaches to pitch organization are represented in the melodies. The more recent of the two studies, Claudio Vanin's 1994 dissertation, examines the applicability of both modes and chains of thirds to the troubadour repertory, drawing on a subset of the melodies for his analysis.[59] He concludes that both approaches have merit for many songs in his study and that for melodies with an established tonal center, the final pitch plays a functional role. He further provides an updated catalogue of musical forms in the melodies, intended to replace that found in Gennrich.[60] Ian Parker also addresses the issue of modal analysis in troubadour and trouvère song, noting the limitations of its application to troubadour song overall while presenting the adherence of a subset of the melodies to modal structures and elements of organization which point towards interval chains (primarily of thirds).[61]

[59] See Claudio Vanin, "Musical Form and Tonal Structure in Troubadour Song" (Ph.D. diss., University of Western Ontario, 1994). There are some differences in range for a small number of melodies used in his study compared to the transcriptions in both the TMD and in Van der Werf's edition.
[60] Vanin, "Musical form," 4. The catalogue is located in his Appendix II.
[61] Ian Parker, "Troubadour and Trouvère Song: Problems in Modal Analysis," *Revue belge de Musicologie* 31 (1977): 20-37, and his dissertation, "Form and Melodic Structure in Troubadour and Trouvère Song" (PhD diss., University of Oxford, 1975), particularly Chapter 4.

Introduction to the Troubadour Melodies Database

The TMD is designed according to the current model of searchable music-related databases such as Cantus, which permit searching of melodies using a graphical representation of the staff.[62] To this general framework, I added resources suited to the case studies which are the focus of chapters II and III. Since earlier encoding projects of troubadour song were not available online, the repertory was not able to be accessed for search or analysis by individuals other than the original researchers; the potential value of a digital melody database thus seemed evident, both for this project and for future troubadour research. The website also includes a Melody Search Tool (adapted from that developed by Jan Koláček) which allows melodies to be searched for either pitch-specific phrases or by a phrase's intervals in transposition, providing a more advanced method to find relationships between melodies than has been possible to date.[63]

The digital component of the project was undertaken with a further goal in mind: the creation of a digital resource available to the scholarly community for the benefit of troubadour studies. The TMD reflects a trend in musicology, and in the humanities more generally, toward long-term digital projects that facilitate academic research and pedagogy while also providing information to a broader audience. It makes available not only resources developed specifically in conjunction with this dissertation, but also a searchable database including the full corpus of

[62] "Cantus Index," http://cantusindex.org/. Databases have also been made for other vernacular repertoires either in their entirety or focused on a topical subject, such as Cantigas de Santa Maria for Singers (http://www.cantigasdesantamaria.com/); another on song in Galician-Portuguese (Cantigas Medievais Galego-Portuguesas (http://cantigas.fcsh.unl.pt/)); and one on troubadour and trouvère songs related to the crusades (Troubadours, Trouvères and the Crusades (https://warwick.ac.uk/fac/arts/modernlanguages/research/french/crusades). For discussions of other database-driven musicological study, see John Walter Hill and Tom T. Ward, "Two Relational Databases for Finding Text Paraphrases in Musicological Research," *Computers and the Humanities* 23, no. 2 (April 1989): 105-111.

[63] The Melody Search Tool is an adaption from Jan Koláček's original for his Global Chant Database (www.globalchant.org) and Cantus (http://cantusindex.org/). The tool is discussed in detail in Chapter I.

melodies supplemented by information regarding their transmission, the troubadours, and the manuscripts. The data reflects the most current research as of the time of writing; in contrast to traditional hard copy appendices and inventories, the digital environment permits future updates.

Additional resources on the site include a table of reference musical characteristics for the melodic corpus generated during this project, including information on the pitches and intervals in the melodies such as first and last pitches, ambitus, number of pitches per melody, and first and final intervals. The tabulated characteristics are thus available to other scholars for further research on the characteristics of the melodies. Reference characteristics can also be used to contextualize particular musical gestures within the entire corpus or a particular troubadour's output; further, they form a basis for comparison of traits of the melodies attributed to one troubadour versus another, or across generations or genres.

Currently, I consider the TMD still incomplete but plan to make further additions. This is in part because the current encoding method (Volpiano, a font which displays alphanumeric strings as musical notation) cannot represent the original neumes or link the pitches directly to the text underlay. The future version of the site will reflect not only the pitches, but also the text-underlay of the first stanzas as found in the sources. I will also include the specific neume shapes used to notate the melodies (currently, neumes are distinguished in the encoding only by the number of pitches they contain). The melodies will also be available for download in Volpiano as well as different encoding methods to facilitate their continued analysis using other approaches that rely on melodies encoded in other formats.[64]

[64] The font was designed by David Hiley and Fabian Weber. See Fabian Weber, "Volpiano," http://www.fawe.de/volpiano/ (accessed 15 November 2019). The font is described on the site as is the history of its development. The site also has versions available for download. The font is discussed in more detail in Chapter I.

Chapter Overview

This dissertation, the prose component of my project, includes a chapter on technical aspects and methodology followed by two chapters which each focus on specific aspects of the repertory and its transmission through case studies in which I apply different types of analysis assisted by computational procedures or digital representations. Supporting materials are available in either the print appendix or through the TMD.

Chapter I provides an overview of the technical components and methodologies used in this dissertation. The first part of the chapter provides a technical introduction to the TMD, including details on the encoding process, a survey of editions, transcription guidelines, and a description of the search features in the database. The second part of the chapter focuses on methods employed in the case studies. I first present my methods for pitch and interval analysis, then those drawn from textual analysis utilized in this project. Each of the digital tools and approaches used in the project are presented along with relevant theoretical underpinnings that accompany these approaches. The chapter concludes with a demonstration of my computational analysis through an overview of the musical features of the four main music sources (*G, R, W,* and *X*).

In Chapter II, I investigate aspects of transmission and musical style using approaches drawn from text mining and computational linguistics.[65] The methods of text analysis applied are the representation and analysis of concordances (appearances of the same word in multiple texts), collocations (words found within a specified proximity to each other), and similarity (the relationship of documents to each other based on the words they contain). These methods of

[65] This application is possible because the encoding method used, Volpiano, represents the melodies as alphanumeric strings.

evaluating texts are applied to the encoded melodies by treating each neume as a separate 'word' so that the software reads each neume as an individual unit made up of the pitches as encoded in Volpiano (for example, 'def---gf--ed' would be three words as divided by the hyphens). For these methods, I use a corpus analysis software platform (AntConc) and Latent Semantic Analysis (LSA).[66] This chapter aims to identify patterns and relationships through distant reading which can then be examined in detail through more traditional close analysis; a combination of both approaches is adopted in the case studies here. I then draw on the data generated from these analytical techniques to address questions about specific features and subgroups of the melodies.

In the first case study, I analyze and describe Guiraut Riquier's use of melismas. I engage here primarily with the scholarly work of Chantal Phan, who observed in one study that the frequent melismas in Riquier's work could reflect his desire to supply written ornaments rather than allocating that task to the performer; moreover, she noted that the melismas serve an essential role through their connections to specific words and their function within his motivic structures.[67] Taking Phan's position that the melismas are a deliberate feature of his style as a starting point, I catalog all of the melismas in Riquier's extant melodies by creating a list of each unique melisma in his songs and tabulating their number of appearances. I then analyze the melismas both for their musical characteristics and for their position with the melodies. From this part of my analysis (contextualized within Aubrey's assertions on typical melisma placement within melodies), I conclude that Riquier demonstrates trends in placement of melismas at final

[66] AntConc is a corpus analysis tool designed by Laurence Anthony. The software is available here: http://www.laurenceanthony.net/software/antconc/ (accessed 1 September 2019). There are multiple type of analysis which can be conducted with LSA; here, I apply a technique which determines how statistically similar each of the melodies is to the others.

[67] Phan, "Structures poético-musicales," 164; Phan, "Le style poético-musical de Guiraut Riquier," 67 and 71. The primary difference between Phan's analysis of Riquier's melodies and mine is that her study focuses on the relationship between the melismas and text based on keywords and the position of melismas with respect to meter.

and internal cadences which set his melodies apart from those of most other troubadours, in addition to identifying stylistic tendencies in his construction of the melismas themselves.

In the second case study, I examine the stability of melody transmission and establish the degree of similarity between the first and second stanzas of melodies in *G* which have all or part of the second stanza notated. To accomplish this, I leverage Latent Semantic Analysis, a technique borrowed from computational linguistics which helps to reveal relationships between texts. The type of LSA used in the study compares documents to find their similarity to each other based on how often words appear in each document. In this type of LSA the order of words (here, pitches) is not a factor; the goal for LSA in this case is thus to identify non-sequential relationships between texts (or in this case, melodies). This is a particularly valuable possibility given the current lack of a 'fuzzy' search for Volpiano, which prohibits searches for similar passages, rather than exact matches, in the melodies.

Due to the experimental nature of applying this technique to encoded melodies, I first demonstrate the validity of LSA for analysis of the troubadour melodies by discussing two works whose security of transmission is established.[68] From these cases, I determine that LSA is effective at identifying related melodies based on their non-sequential pitch content to identify possible relationships that would not be found though the standard sequential search available through the TMD. I then locate concordances with different degrees of stability in their transmission. First, I discuss the features of a song that I preliminarily identified as the melody with the highest similarity scores for its concordances outside the previous two examples.[69] I

[68] Matfre Ermengau's "Dregz de natura" (BEdT 297,004) and Richard I of England's ("the Lionheart") "Ia nuls hons pris ne dira" (BEdT 420,002).
[69] Peirol's "Coras qem fezes doler" (BEdT 366,009).

then analyze the concordances of a song whose melody transmission is unstable.[70] Additionally, my analysis of all concordances in the repertory through this approach confirms that the only cases of near-total stability in melody transmission occur outside the troubadour chansonniers, appearing only in copies of the *Breviari d'amor* and a few trouvère chansonniers.[71]

In the last section of the case study, I apply the similarity analysis to the melodies in *G* which have at least one phrase of the second stanza notated. I conduct phrase comparison analysis of the first phrase of both stanzas as well as the entire stanza 1 and 2 melodies for the two songs which have two stanzas notated (along with the incipit of stanza 3). I determine that the variations in the versions are typically minimal and most often show a shift in syllables in the line which could be intentional or could be the result of scribal error. I also note that in two cases the phrase for stanza 2 is incorrect; one of these cases is fairly clearly scribal error, but the other is a seemingly-shared incipit from a melody that is only found in *W*.

My computational comparison of the similarity of the melodies thus allows me to not only identify trends in melody similarity more generally, but also allow me to articulate the statistical degree to which the first and second notated stanzas in *G* are similar. I then combine this distant reading method with close-reading of the melodies to evaluate the musical features which diverge or overlap between the concordances to identify how the melodies differ musically. Application of these textual analysis techniques thus allows a higher-degree of specificity and control of the repertory's musical features during analysis, while also providing

[70] Folquet de Marseilla's "Greu feira nuls hom faillensa" (BEdT 155,010).
[71] Hebbard addresses the stability of transmission for Matfre's "Dregz de natura" in her dissertation: "Manuscripts," 173.

evidence for more general conclusions about the relationships between the melodies used to set the first and second stanzas of some songs.

In Chapter III, I present three case studies that apply computational methods to the pitch and intervallic characteristics of troubadour song.[72] In the first case study, I compare the music composed by troubadours assigned to the third and fourth generation by Aubrey. My intent with this analysis is to verify the usefulness of such a classification to establish chronological trends in style. Based on the results of my analysis, I determine the limitations to Aubrey's division and propose an alternative division of the corpus for chronological comparison and analysis in the second half of the study.[73]

Throughout the case study I engage with Aubrey's conclusions about style for the melodies in her generations as well as her claims about chronological changes in musical style in the repertory. Overall, my analysis confirms several of the large-scale trends Aubrey proposed. I conclude from my analysis that the melodies surviving from her fourth-generation troubadours display, in general, greater diversity in the aspects of musical style compared to the third, despite the smaller number of fourth-generation melodies extant and the larger number of third-generation troubadours represented.

Moreover, I determine that Aubrey's generations, while useful for investigating aspects of troubadour biography, limit broad scale analysis because two of her generations are so small that stylistic features of that generation cannot be established. I thus propose dividing the corpus into six groups based on troubadour end date (each group in this division has at least forty

[72] Each case study examines a particular aspect of or question about the repertory using the Melody Analysis Tool developed for the project. For more information on the Melody Analysis Tool, see Chapter I.
[73] I limit the songs analyzed to those with attributions which are not too fragmentary for analysis (312 melodies).

melodies). This approach has the advantage that each of these periods has a sufficient number of melodies for analysis; this allows their musical features, and stylistic changes over time, to be identified on the basis of more robust evidence.

For the second case study, I analyze pitch organization in the melodies. First, I provide an overview of previous perspectives on how pitch is organized in the melodies. These studies include research by Theodore Karp on modality, Ian Parker's studies of form and style, the overall description of the repertory provided by Van der Werf in his edition of the melodies, and a study on mode in troubadour song by Claudio Vanin.[74] In the case study, I consider the musical features of the church modes (final pitch, range, and range both above and below the final pitch) as well as other forms of musical emphasis (repetition of pitches and the position of notes at the beginnings and ends of phrases). I first present how these musical features appear in the repertory overall, then demonstrate how pitch organization relates to modal analysis of the melodies. I conclude that, while the modal system derived from the chant repertory was likely influential for troubadours to different degrees, there is no consistent application of modal pitch

[74] The scholarship on pitch organization is discussed in more detail in the case study itself, but I provide here a brief summary of those engaged with in the chapter. Theodore Karp published multiple times on mode in this and related repertoires, noting where the melodies tend to fit modal theory or not. See his summary article in Grove Online, "Troubadours, Trouvères: Modality," *Grove Music Online,* ed. Deane Root, http://www.oxfordmusiconline.com (accessed 26 December 2017). For an overview of how modes are structured, see Leo Treitler, "The Troubadours Singing Their Poems," in *The Union of Words and Music in Medieval Poetry*, ed. Rebecca A. Baltzer, Thomas Cable, and James I. Wimsatt, 15-48 (Austin: University of Texas Press, 1991), 21-23. Margaret Switten adopts parts of the modal approach to help discuss and organize melodies, such as the final, while noting what features of modal analysis do or do not fit with individual melodies. Margaret Switten, *Cansos of Raimon de Miraval* (Cambridge, MA: Medieval Academy of America, 1985), 17. She gives an overview of perspectives on modality in troubadour song in pages 17-20. Van der Werf, *Extant*, 31-32. Hendrik Van der Werf avoids using modal terminology because of its lack of applicability to many of the melodies. Instead, he prefers to describe melodies in terms of their alignment with what he terms a major or minor medieval scale. Ian Parker's dissertation and subsequent article address the issue of modal analysis, noting the limitations of its application to troubadour song. Ian Parker, "Troubadour and Trouvère Song" and "Form and Melodic Structure," particularly Chapter 4. Vanin's 1994 dissertation examines the applicability of both modes and chains of thirds to the troubadour repertory, drawing on a selected subset of the melodies for his analysis. Vanin, "Musical form." Elizabeth Aubrey's study points to the difficulty of establishing a consistent role of a final pitch and the prevalence of melodies which have more than one pitch center. Aubrey, *Music of the Troubadours*, 174-176.

organization in their melodies.

The third case study begins with a review of Matthew Steel's statistical analysis of the repertory in his 1989 dissertation.[75] His analysis focused on text-setting styles and the use of intervallic leaps to show differences in style between the four main music sources (*G, R, W,* and *X*); he limited the application of his analysis to a subset of melodies by six troubadours which appear in at least three versions in the main sources.[76] I first compare Steel's results to my own analysis of the same subset of songs, then expand my analysis to the entire contents of *G, R, W,* and *X* to assess his conclusions about style in the sources on a broader scale. I further discuss the appearance of *plicas* in the melody and their impact on the melismatic and stepwise qualities of the melodies, as this is an aspect of the repertory which Steel references and hypothesizes about, but could not include in his analysis.[77]

My broader analytical scope confirms a few of Steel's conclusions but suggests some important deviations (such as that *W* has the most examples of leaps a third or larger, rather than *G*). I also conclude that of the four manuscripts, *R* has the most melismatic melodies overall and has the most melodies with a predominance of stepwise motion. I further determine that *plicas* impact the intervallic structure of melodies most in *W* because it has the highest concentration of *plicas* of the four main sources. This case study thus contributes a statistical evaluation of style in the main sources based on the entire contents of *G, R, W,* and *X* while validating or supplementing Steel's conclusions. It also contributes a systematic statistical comparison of

[75] Matthew Steel, "Influences."
[76] The six troubadours are Bernart de Ventadorn, Folquet de Marseilla, Gaucelm Faidit, Jaufre Rudel, Peire Vidal, and Richart de Berbezill.
[77] *Plicas* are liquescent neumes that typically served a passing function or anticipated the subsequent note. They thus fill in a larger interval (typically a third) while also adding one note to the number of pitches over a syllable.

troubadour melody features both with and without *plicas*, as well as generating a dataset on *plica* appearances by melody and source.

Chapter I

Technical Description and Methodology

Tools from the digital humanities have created new opportunities for analysis and representation of the characteristics and transmission of the troubadour tradition. These methods open the way for new interpretation of certain features and for improved communication of the results of such study.[78] Prior to presenting applications of my analysis in the following chapters, I first outline the different methodological assumptions and technologies applied, then provide further context for the materials utilized in the project. The first part of the chapter presents a technical introduction to the TMD, including details on the encoding process, a survey of editions, my guidelines for transcription and encoding, and a description of the search tool currently in the database.

The second part of the chapter focuses on the specific methods and software employed in the case studies. First, I present the methods I use for pitch and interval analysis, followed by a discussion of the approaches and tools I borrow from textual analysis with specifics on how I customize those tools for the purposes of this project. The chapter concludes with a

[78] An overview of digital musicology can be found in Ichiro Fujinaga and Susan Forscher Weiss, "Music," in *A Companion to Digital Humanities*, ed. Susan Schreibman, Ray Siemans and John Unsworth (Oxford: Blackwell, 2004), 97-170. A related but more recent survey of digital musical analysis was published in 2016: John Ashley Burgoyne, Ichiro Fujinaga, and J. Stephen Downie, "Music Information Retrieval," in *A New Companion to Digital Humanities*, ed. Susan Schreibman, Ray Siemens, and John Unsworth (Malden, MA, USA: John Wiley and Sons, Ltd., 2016), 260-279. The authors note that the terms "computational musicology" and "music information retrieval" both date to the 1960s. Burgoyne, et. al., 261. A survey of musical computer analysis and a classification of types of such analysis is the focus of Nico Schuler's 2000 dissertation: Nico Stephan Schuler, "Methods of Computer-Assisted Music Analysis: History, Classification, and Evaluation" (PhD diss., Michigan State University, 2000). A short overview of the state of digital musicology, its challenges, and relevant projects, can be found in Laurent Pugin, "The Challenge of Data in Digital Musicology," *Frontiers in Digital Humanities* 2, article 4 (August 2015): 1-3.

demonstration of my computational analysis through an overview of the musical features of the four main music manuscripts (*G, R, W,* and *X*).

Introduction to the Troubadour Melodies Database

In my project, I digitally encoded the entire troubadour melodic corpus and created an online database to capture data and metadata relevant to this repertory (the TMD). The aim of the project was to make the melodies searchable and to facilitate investigation of their characteristics. Analysis of the melodies assists in comparing style across time and space, as well as in finding both high- and low-level connections between melodies which could reflect relationships either between troubadours or manuscripts. I define a high-level connection as one or more melodic phrases shared between two melodies, while a low-level relationship is one based on shorter (but still distinctive) similarities.

Song Identification in the TMD

The database allows the melodies to be browsed by various features (troubadour, attribution, incipit, genre, and catalog number) to maximize discoverability. In this section, I briefly outline the procedures I followed to build this dataset. The TMD draws on the main catalog for troubadour lyric used by scholars: that of Alfred Pillet and Henry Carstens, first published in 1933.[79] In their catalog (usually identified by the siglum PC), each troubadour song appears with a standardized incipit and a list of its sources; the catalog is organized by troubadour, with short descriptions of each author at the head of their worklist. Each song is

[79] Pillet, *Bibliographie der Troubadours*.

identified in the catalog through a system of two numbers: the first number identifies the troubadour and the second specifies the song alphabetically within that troubadour's worklist. For example, PC 46,002 identifies the song as "A chantar," the second song alphabetically by incipit of the works attributed to the Comtessa de Dia (troubadour 46 in the catalog). In some cases catalog numbers include a letter; this marks a later addition to the catalog (461,251a, for example, falls alphabetically between two anonymous works already cataloged as 461,251 and 461,252).

Since 2012, the online database the Bibliografia Elettronica dei Trovatori (known as the BEdT) provides a compilation of information about troubadour song from existing scholarship. [80] The BEdT's catalog numbers are based on PC; either PC or BEdT numbers are the standard in troubadour scholarship to identify songs when discussing either the text, melody, or both.[81] The melodies in the TMD are identified through a unique database ID number derived from the BEdT catalog numbers for each song.[82] In the case of unica, melodies are identified by their BEdT ID number (461148, 46002, etc.). When a song has multiple melodies extant in sources (concordant or discordant), the melodies are identified by the combination of their BEdT ID and the sigla of the source they appear in (70001W for the version of BEdT 70,001 appearing in *W*, 70001R for the version appearing in *R*, etc.).

[80] Bibliografia Elettronica dei Trovatori.

[81] There is not a separate catalog system for melodies that has been adopted by scholars. Editions have either used the standard catalog numbers described here or simply numbered the songs within troubadour groups or sequentially throughout the edition.

[82] In two cases the BEdT does not include a number for a song with a melody, in which case the catalog number is derived from another catalog, study, or edition that assigns the song an id number. Both of these cases are from the *SJA* fragment. 461,020b does not appear in either the BEdT or the PC catalog, but it is given this number in Gerald Bond, "The Last Unpublished Troubadour Songs," *Speculum* 60, no. 4 (1985): 829. 461,215b* is assigned to a different song in the BEdT but the song is given this number in Bond's article as well as Gennrich's edition.

The TMD includes information about each of the melodies including basic musical characteristics. Two versions of the incipit are given for each melody. One is that as found in the manuscript, and the second is the 'standardized' incipit for that song as it appears in the BEdT (typically derived from those in PC). In some cases the two incipits are quite similar, with minor orthographic differences, while in other cases they differ in spelling, words, word order, or simply differ completely because of a difference in stanza order between the sources. Throughout this dissertation, songs are identified by their BEdT catalog number and incipit for clarity, as some songs have quite similar incipits and the inclusion of the unique catalog number clarifies which song is referenced. As for the sources of the melodies, the database records identify the location of each melody by manuscript sigla and folio number. The melody records also list the attribution both from the original source and that based on modern scholarship. Genres are given in the melody records as well; as discussed previously, several publication assign genres to the extant troubadour songs. The TMD includes those assigned in the BEdT.[83] Information on the troubadour manuscripts within the database is drawn from current scholarship and my own study of their contents.[84] The melodic characteristics available for each melody within the site (such as first and last pitches, ranges, etc.) are my own contribution, derived from my analysis of the encoded melodies.

Despite the sixty years since the first digital and computational musicology projects, such efforts still do not make up a significant number of research projects in the field today. As Nicholas Cook noted in 2004, computational musicology had not yet then become a major

[83] The BEdT includes four genre designations in each record: that from Frank, PC, the BdT (a regularized and Italian translation of those in Pillet), and its own BEdT genre designation. The BEdT's own genre assignment for each song appears in the TMD.
[84] A list of all sources relevant to the project with their date and place of origin, as well as the source for that information, can be found in the TMD.

feature of the broader musicological field in part because of a decline of interest in comparative musicology, despite its potential contribution to the field.[85] Cook concluded his discussion of the opportunities presented by computational approaches for musicology by affirming that humanist and computational approaches are mutually beneficial, not mutually exclusive.[86] Like Cook, I believe a combination of humanist and statistical approaches benefit scholarship; I thus interweave the two in both the TMD and this dissertation.

Methods of encoding and analyzing music have been available for several decades in a variety of formats.[87] Tools for analysis of these various types of encoding have naturally developed alongside the encoding methods themselves. Prominent musical analysis software include the Humdrum Toolkit, developed by David Huron, which has remained a functioning musical analysis tool for three decades, and Michael Cuthbert's music21 Python-based program, an actively developing tool that interfaces with multiple encoding systems.[88]

Several previous studies, discussed below, applied one or more computational or digital approach to the troubadour melodies; the current project differs from these in either the scope of the encoded repertory, as many previous projects focused on a subset of the troubadour melodies,

[85] Cook states that: "Perversely, this meant that the possibility of computational approaches to the study of music arose just as the idea of comparing large bodies of musical data—the kind of work to which computers are ideally suited—became intellectually unfashionable. As a result, computational methods have up to now played a more or less marginal role in the development of the discipline." Nicholas Cook, "Computational and Comparative Musicology," in *Empirical Musicology*, ed. Eric Clarke and Nicholas Cook, 103-126 (Oxford: Oxford University Press, 2004), 103. Digital musicology still comprises a small number of presentations at the annual meeting of the American Musicological Society, but is becoming increasingly more common.
[86] Cook, "Computational and Comparative Musicology," 123.
[87] A review of the encoding methods available for music notation c.1990 is available in Walter B. Hewlett and Eleanor Selfridge-Field, "Encoding Neumes and Mensural Notation," *Computing in Musicology* 6 (1990): 23-35. Methods of encoding music for analysis by computers date back to at least the 1950s; a list of musical corpora available in 1972 includes musical repertoires from Bach to Josquin to Wagner on punch cards, magnetic tape, and paper tape. "Music in Machine Readable Form," *Computers and the Humanities* 6, no. 3 (January 1972): 176-178.
[88] "The Humdrum Toolkit: Software for Music Research," http://www.humdrum.org/; Michael Cuthbert, "music21: a Toolkit for computer-aided musicology," http://web.mit.edu/music21/. Humdrum is used as a case study in Cook, "Computational and Comparative Musicology."

or in the scope of the analysis. David Halperin used Fortran (Formula Translation) to analyze structural patterns in the intervals in the melodies in his thesis; for his project, he encoded the melodies from Gennrich's edition.[89] The goal of his project differed from mine in that it specifically focused on looking for "the structure of a phrase" and resulted in a list of initial and final formulas located through his analysis.[90] Halperin then used the data to identify patterns of intervals in incipits and closing cadences. In a second computational project on the troubadours, Halperin applied a method of ordering melodies called seriation for a subset of the troubadours; the study emphasizes statistical chronological ordering as a way of evaluating if a troubadour is "conservative" or "forward-looking," which overlooks the extent of musical variety throughout the period of troubadour activity.[91]

A study published in 1982 by Alastair Pearce applied computational methods to five melodies by Bernart de Ventadorn and Guiraut Riquier; he used King's Music Analysis Package (KINGMAP) to compare the melodies, which he encoded in DARMS (a computer language developed specifically to encode music).[92] Pearce sought to establish whether the two troubadours employed melodic material from their incipits later in their melodies and if they

[89] David Halperin, "A Structural Analysis of Troubadour Song." An article with a summary of the thesis's results and methods are found in David Halperin, "Distributional Structure in Troubadour Song," 15-26. He outlines the assumptions and parameters for the analysis as follows: his method ignores repeated notes and encoded descending intervals as negative integers and ascending ones as positive integers without a plus sign (-2 2 would be descending then ascending, for example). His analysis also did not differentiate *plicas* in the encoding, so they were treated in the same way as other notes. Halperin, "A Structural Analysis," 11-12 and 25-26; Halperin, "Distributional Structure," 15 and 24-26. Fortran is a computer language often used for computation which has largely been replaced outside of specialized scientific fields.
[90] Halperin, "Distributional Structure," 15 and 24-26.
[91] David Halperin, "Musical Chronology by Seriation," *Computers and the Humanities* 28, no. 1 (1994): 13-18.
[92] Alastair Pearce, "Troubadours and Transposition: A Computer-aided Study," *Computers and the Humanities* 16 (1982): 11-18. A discussion of DARMS can be found in Raymond F. Erickson, "'The DARMS Project': A Status Report," *Computers and the Humanities* 9, no. 6 (November 1975): 291-298.

used transposition differently; he concludes the results were mixed, but claims that they do differ in their transposition of motives.[93]

In his 1989 dissertation, Matthew Steel computed the number of pitches per syllable ("pitch density") and the number of intervals a third and larger in each melody.[94] His work compared the musical style of the four main sources based on the melodies of six troubadours who have melodies with at least three versions extant in *G, R, W,* and *X*. Steel also explicitly divides the melodies into a core and satellite repertory in his discussion of the repertory; the melodies that form the basis for his analysis in the study all come from the core.[95] Two recent projects that encoded troubadour melodies for analysis are the Troubadour Encoding Project, in which Eamonn Bell and Russell O'Rourke, supervised by musicologist Susan Boynton at Columbia University in 2014-2015, encoded Van der Werf's edition in Kern format for modal and pattern analysis using the Humdrum Toolkit,[96] and Stefano Milonia's 2016 database of rhyme and melody, which includes motives from the melodies represented as letters to show their coordination to rhymes.[97]

Survey of Editions

Prior to embarking on the actual encoding of the melodies, I surveyed the existing editions and studies of troubadour song to assess the actual size of the melodic corpus to be

[93] Pearce, "Troubadours and Transposition," 11.
[94] Steel, "Influences." Steel does not outline the technical aspects of his computations.
[95] For lists of his core and satellite repertoires, see Steel, "Influences," Appendix A and B.
[96] A brief summary of the project is available here: "Early Music conference strives to preserve tradition in digital age," https://www.columbiaspectator.com/arts-and-entertainment/2014/10/23/early-music-conference-strives-preserve-tradition-digital-age/ (accessed 15 November 2019).
[97] Stefano Milonia, *Rima e melodia nell'arte allusiva dei trovatori* (Rome: Edizioni Nuova cultura, 2016). The database itself is available as a CD-ROM which accompanies the volume.

encoded for the database; I also examined the editions for differences in editorial practices, the results of which are discussed below. I next surveyed the general musical features of the repertory to determine which encoding method would be suitable.

The first complete edition of troubadour melodies, Friedrich Gennrichs's *Der musikalische Nachlass der Troubadours*, appeared in three volumes from 1958-1966.[98] His edition includes 302 melodies transcribed in modern rhythmic notation; transcriptions of the original notation for many of the melodies appears in edition as well.[99] He included melodies from nearly all of the known sources as well as fifteen contrafacts he compiled that do not appear in medieval sources.[100] Gennrich also transcribed melodies extracted from polyphonic settings in the edition. His transcriptions include PC numbers for the songs for ease of identification. Two complete editions of troubadour melodies were published within twenty years of Gennrich's edition: *The Extant Troubadour Melodies: Transcriptions and Essays*, with melodies edited by Hendrik van der Werf and texts edited by Gerald Bond, and *Las Cançons dels trobadors*, edited

[98] Friedrich Gennrich, *Nachlass*. An edition of the complete melodies was planned by Beck prior to Gennrich's edition but never completed. See Haines, "The First Musical Edition of the Troubadours," for his survey of the history of editions of troubadour melodies. Willi Apel also planned an edition of troubadour songs that was never completed; the only part of the project known to exist is an eight-volume set of hand-corrected typed pages with the texts of all of the troubadour songs planned for inclusion in the edition. These volumes are held in the collection of the William and Gayle Cook Music Library at Indiana University, Bloomington, IN. The catalog record for the item is available here: https://iucat.iu.edu/catalog/4538198 (accessed 17 November 2019).

[99] Margaret Switten describes the usefulness of this edition as: "furnish[ing] an enormous amount of important information and, from that standpoint, has not been replaced. But regularization of the melodies and transcription in modal rhythm diminish the edition's value as an indicator of what the sources actually contain." Margaret Switten, Review of *The Extant Troubadour Melodies: Transcriptions and Essays for Performers and Scholars*, by Hendrik van der Werf. *Journal of the American Musicological Society* 20, no. 2 (Summer 1986): 381.

[100] These are Nos. 287-302 in his edition. Several modern editors and performers create their own contrafacts, songs which use the melody of one song to set the text of another with the same metrical structure. The creation of contrafacts not found in extant sources is a stratagem that allows performance, recording, or publishing of a musical setting of a particular text. Modern contrafacts are thus combinations born from the alignment of metrical and (possibly) rhyme schemes; they have a practical function in expanding the songs which may be sung rather than recited, but there is not always historical evidence to suggest that these contrafacts existed during the medieval period.

by Ismael Fernandez de la Cuesta and Robert Lafont.[101] The earlier of the two, *Cançons dels trobadors*, contains 360 melodies including twenty modern contrafacts. *The Extant Troubadour Melodies* includes 311 troubadour melodies as well as contrafacts of those melodies in other languages (primarily Old French).[102] In addition to these complete editions, there are also numerous publications with selections from the repertory, such as those attributed to a particular troubadour (or group of troubadours). These editions were also examined during the planning stages of the project and are referenced as necessary; however, the focus here will be on the most recent editions (those of Cuesta and Van der Werf) which aimed to present the entirety of troubadour melody. Both editions omit some melodies which are included in the TMD.[103]

Van der Werf and Cuesta made several different choices in their representation of the melodies, although both used stemless note heads for their transcriptions instead of specifying rhythmic values. Both authors collate melody concordances so that all melodies for a particular song are included in the edition and can be easily compared to one another. For the underlay, Cuesta's edition follows a single 'best text' approach by choosing one edition of a text to use for the underlay of the collated melodies rather than providing each text as found in each manuscript. Even in the case of unica melodies, he does not always use the text found with the melody in its source. In contrast, Hendrik Van der Werf's *Extant Troubadour Melodies* presents texts and melodies as they are paired in the sources. He does, however, make editorial

[101] Van der Werf, *Extant Troubadour Melodies*; Ismael Fernandez de la Cuesta and Robert Lafont, *Las Cançons dels trobador*s (Toulouse: Institut d'estudis occitans, 1979). Other partial editions of the repertory have been published which contain a fairly large subsection of the repertory, such as those of Christelle Chaillou, *Faire los motz e-l so* (Turnhout: Brepols, 2013) and Antoni Rossell i Mayo, *El cant dels trobadors* ([Girona]: Ajuntament Castelló d'Empúries, [1992]). Cuesta does not include the catalog numbers of songs, identifying them only by troubadour and incipit; Van der Werf identifies each song by its PC catalog number.
[102] Van der Werf includes a discussion of contrafacture in troubadour song in his edition. See Van der Werf, *Extant Troubadour Melodies*, 72-74.
[103] Appendix B includes concordances for these editions.

interventions such as the transposition of several melodies (typically in the case of ones with multiple versions to make them easier to compare by having them start on the same pitch); these and other alterations are identified in the critical notes for each melody. When Van der Werf deviated from the notes in the manuscripts, such as when he believed the notated pitch to be a mistake because of its musical context, he detailed the changes made in the critical notes for each melody. Cuesta's edition lacks such notes; his edition includes the shapes of the original neumatic notation over the modern transcription, which Van der Werf's does not, but Cuesta's edition is less accurate overall than that by Van der Werf.[104]

The rhythmic interpretation of troubadour and trouvère song has been vigorously debated by scholars for well over a century. Rhythmic editions of trouvère song in triple meter appeared in the eighteenth century.[105] In the nineteenth century, other approaches were developed by Hugo Riemann, Pierre Aubry, and Jean Beck; twentieth-century scholars debated the merits of three

[104] The melodies in the TMD do not have comments noting differences between my transcriptions and Cuesta's for this reason. Margaret Switten summarizes the flaws of the Cuesta edition in her review of Van der Werf's *Extant Troubadour Melodies*: "The most recent collection of troubadour melodies has been made by Ismael Fernandez de la Cuesta, *Las cançons dels trobadors* (1979). This edition takes over much of Gennrich's material but presents all versions of each melody in nonmensural notation, utilizing medieval note forms above the staff. This would be splendid if de la Cuesta's edition were not marred by an incredible number of errors in transcription and by a presentation of texts that can only be termed absurd; thus it is, for all scholarly purposes, useless." Switten, Review of *The Extant Troubadour Melodies*, 381.

[105] Donna J. Mayer-Martin, "Melodic Materials in Trouvère Music: A Comparative Analysis of the Chansons of Chatelain de Coucy, Gace Brule, Thibaut de Champagne, and Gillebert de Berneville" (PhD diss., University of Cincinnati, College-Conservatory of Music, 1981), 99. John Haines summarizes early editions of trouvère song which use rhythmic interpretations in his "The Footnote Quarrels of the Modal Theory: A Remarkable Episode in the Reception of Medieval Music," *Early Music History* 30 (2001): 93, n. 5. These editions include Jean Benjamin de La Borde, *Essai sur la musique ancienne et moderne* (Paris: Ph. D. Pierres, 1853); John Stafford, *Musica Antiqua* (London: Preston, 1812), which contains eleven trouvère songs transcribed in triple meter; Edmond-Charles-Henri de Coussemaker, *Œuvres complètes du trouvère Adam de la Halle* (Paris: A. Durand & Pédone-Lauriel, 1872), and François-Joseph Fétis, *Histoire générale de la musique* (Paris: Didot, 1876).

main approaches (modal, isosyllabic, and free, or declamatory).[106] Examination of these historical editions can still be valuable in cases where an editor's reading of a source occurred prior to damage during restoration or rebinding (as in the case of *W*). The current standard for transcribing troubadour song in scholarly editions is the same approach typically used for chant: the pitches are represented by stemless note heads, with *plicas* marked by a slashed stem or a smaller note head. With the amassed scholarship on this issue in mind, I agree with the current perspective that the notation which transmits the melodies does not, with very few exceptions, contain rhythmic information. I thus follow current editorial practice by transcribing the melodies as stemless note heads without rhythmic indication.

Why Return to the Sources for the TMD

Several factors outlined in the preceding discussion of editions and editorial practice determined my decision to transcribe the melodies directly from the sources themselves rather than to choose one (or multiple) editions to serve as the basis for the database. First, no one edition included all of the melodies I needed for the TMD based on my definition of the

[106] For an overview of the modal debate between Riemann, Aubry, Beck, and others, see Haines, "Footnote Quarrels." The modal rhythmic approach transcribed the melodies using patterns from the rhythmic modes; it gradually fell out of favor, as reflected in work by Higinio Anglès, Friedrich Gennrich, and Jacques Chailley, who noted the need for alterations to the system to suit various repertoires, with the result that the modal approach could not be applied universally. Haines, "Footnote," 118-119. Hans Tischler continued to publish on the applicability of modal rhythm and used this method in his published transcriptions of songs throughout his career (see for example Hans Tischler, "The Performance of Medieval Songs," *Revue belge de Musicologie* 40 (1989): 225-42). John Stevens laid out the tenants of his isosyllabic (or isochronic) approach in his *Words and Music in the Middle Ages: Song, Narrative, Dance and Drama, 1050-1350* (Cambridge: Cambridge University Press, 1986). This approach sings each syllable for roughly the same duration, so notes which appear over the same syllable are sung in the same amount of time as a pitch which is the only note for a syllable. The free (or declamatory) approach has been discussed extensively by Hendrik Van der Werf, and is the method currently used by most scholars. One example of his publication using this approach to transcription is Hendrik Van der Werf, *The Chansons of the Troubadours and Trouvères: A Study of the Melodies and their Relation to the Poems* (Epe: Hooiberg NV, 1972).

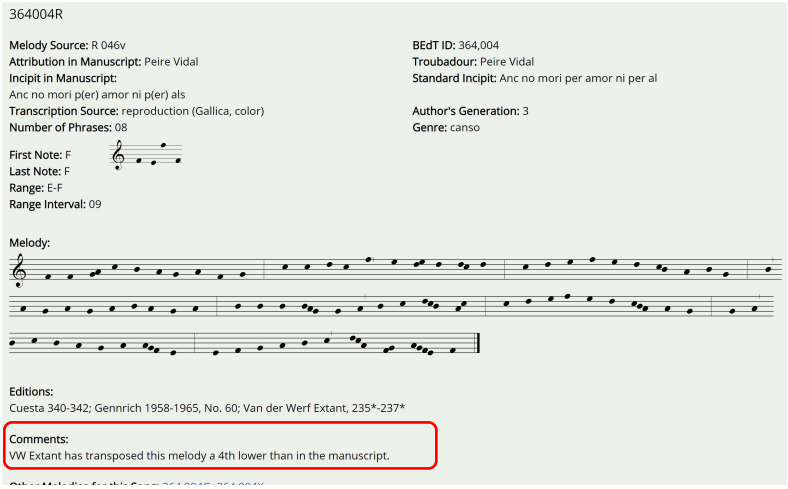
repertory; this would have resulted in the need to transcribe melodies from multiple editions that followed different practices (not all of which are made transparent to the reader through critical notes or introductions to the editions). Such an approach would have resulted in an inconsistent corpus of encoded melodies which would have thus had inconsistent analytical results. The editions all include some measure of alteration through various corrections and completions in their transcriptions of at least some melodies, ranging from the alteration of a few pitches to the transposition of entire melodies. Second, there is the issue of copyright; even in the spirit of fair use, it would have been a breach of copyright to encode the entirety of an edition and make it available online without permission of the copyright holder. The best choice for an edition to encode is that of Van der Werf; however, that edition is still in copyright.[107]

I thus chose to use diplomatic transcriptions of the melodies I transcribed from the sources for the encoded melodies in the TMD. This approach ensured the melodies in my database did not violate copyright protections of existing editions while also ensuring the melodies aligned with those in the manuscripts. The TMD transcriptions thus pursue the goal of communicating, as Margaret Switten articulated, the pitches as found in the sources.[108] I approached this goal by transcribing the melodies afresh from the sources themselves or the best images now available, which are overall a considerable improvement from what many previous editors had available to them. When the melodies are converted to MEI (Music Encoding Initiative), the diplomatic transcriptions will be able to be annotated to include proposed editorial changes, transcription differences between editions, erasures, and other features of the

[107] The edition was self-published by Van der Werf; there is thus not a publishing company to contact for permission to use the edition. My efforts to contact Van der Werf himself about some features of his edition were not successful.
[108] Switten, Review of *The Extant Troubadour Melodies*, 381.

transcriptions. The original diplomatic transcriptions created for this project are thus an essential step in the larger plan for the project.

Diplomatic transcriptions also provide context for the editorial changes made by previous scholars and editors. After I transcribed the melodies, I compared them to the transcriptions in Van der Werf; for melodies he did not edit, I compared my transcriptions to another published edition whenever possible. Any melodies which differ in my transcriptions from Van der Werf's have comments noting those differences in their TMD melody record (see Figure 1.1).[109]



Comments:
VW Extant has transposed this melody a 4th lower than in the manuscript.

Figure 1.1: Comments in TMD for "Anc no mori per amor" (BEdT 364,004) in R

I avoid here the now-rejected belief that there is an urtext of each troubadour melody (that there is an 'authentic' melody which best reflects the composer's intentions), with the exception of the

[109] I also include notes stating which melodies were excluded from Van der Werf's edition, as well as if a melody was excluded from Aubrey's study of the troubadours, in an effort to increase transparency of what melodies different scholars are referring to when they describe the features or define the extent of troubadour melody.

melodies by Guiraut Riquier, which are stated in one source to have been copied after an exemplar in his own hand.[110] I stress the importance of including all troubadour melodies as works sufficient on their own rather than attempting to identify one melody among a song's concordances that is an 'original' or 'most authentic' version of the melody. This further means that I include all versions of melodies in analysis, rather than choosing one melody from a set of concordances to be representative of the entire group.[111]

Encoding the Troubadour Melodies

As a first step in the encoding process, I determined the repertory that would be included in the database. I compiled a list of all melodies with Occitan texts included in previous editions and studies and all of the sources known to contain melodies. I also searched for manuscripts with evidence of musical planning without notated melodies to gather as complete a list of sources with any degree of musical evidence as possible. Once Hebbard's new catalog of sources became available, I compared my repertory and list of sources to hers and made a small number of updates, including matching the manuscript sigla in the TMD with those in her updated

[110] This topic is discussed further in Chapter II, Case Study 1. For discussion of the problems in the concept of an original authoritative melody in troubadour song, see Margaret Switten, "Music and Versification," in *The Troubadours: An Introduction*, ed. Simon Gaunt and Sarah Kay, 141-163 (New York: Cambridge University Press, 1999), 142.

[111] There are two songs which have melodies so similar in their concordances they can truly be considered the same melody: those melodies for "Ja nuls on pris" (BEdT 420,002), by Richard "the Lionheart," and "Dregz de natura," (BEdT 297,004) by Matfre Ermengau.

catalog.[112] Of the 342 surviving melodies and fragments, 265 are unica; three songs have four extant melodies, seventeen have three melodies, and thirty-four have two melodies.[113] The melodies with concordances range from quite similar, to related, to discordant. Twenty manuscripts and fragments preserve songs with musical notation included in the TMD; only four of these contain more than a few melodies.

Aside from the paucity of melodies overall, there is some disagreement among musicologists about the extent of the repertory.[114] Friedrich Gennrich included 302 melodies in his edition published between 1958 and 1965.[115] Halperin included 285 of the melodies published by Gennrich in his computational study of troubadour song, including his modern (hypothetical) contrafacts.[116] Van der Werf gives 311 melodies in his edition; his reasons for the exclusion of melodies from his repertory are outlined in the critical notes for the edition (including genre, form, date of copying, and degree of influence from other languages on the Old

[112] For the TMD, I included only melodies found in medieval sources (I thus exclude *Mad* and *Fb*, which each have one melody: BEdT 155,014 and 461,199a, respectively) whose pitch could be clearly determined (*Lat1139* excluded, with three melodies: BEdT 461,046a; 461,164b; 461,181a). I also only include melodies found as monophony in the source (excluding *Mo196* (BEdT 461,148a; 461, 170a; 461,240a), *Naf* (BEdT 461,170a), *W2* (BEdT 461,102a), and one motet in *Delta* (BEdT 461,170a). I excluded troubadour songs found within motets for this stage of the project because Volpiano cannot encode polyphony; I plan to include them in the database once I can do so with both a searchable version of the identified troubadour melody as well as the polyphonic setting itself to provide the full context for the melodies instead of extracting them as monophonic works only. For individual information on these sources, see Hebbard, "Manuscripts," Appendix A.

[113] See Appendix B for a concordance of melody appearances in major editions and studies. I do not include melodies with sacred texts in Old Occitan without a clear reading for pitch level or melodies transcribed from polyphonic works here. These are all encoded in the digital component of my dissertation, the TMD (count as of September 2019).

[114] See Appendix B for a concordance table of the melodies in relevant editions and studies. Hebbard discusses this in her work as well. Hebbard, "Manuscripts," 127.

[115] Gennrich, *Nachlass*, 1958-1965. An edition of the complete melodies was planned by Beck prior to Gennrich's edition but never completed. See John Haines, "The First Musical Edition of the Troubadours," for his discussion of the history of editions of troubadour melodies.

[116] David Halperin, "A Structural Analysis of Troubadour Song." The goal of his project differed from this one in that it specifically focused on "the structure of a phrase" and resulted in a list of initial and final formulas located through his analysis. Halperin, "Distributional Structure," 15, 24-26. His study is not engaged with directly in this dissertation because of the inclusion of a significant number of melodies in his analysis that were not encoded for this project (specifically Gennrich's contrafacts and the melodies found within polyphonic settings), making direct comparisons between his results and mine unfeasible.

Occitan texts).[117] In his dissertation on style in troubadour song, Steel lists 360 melodies in his corpus. His count includes several sacred works in Old Occitan whose pitch level is ambiguous as well as troubadour melodies that have been identified within the voices of motets.[118] According to Aubrey, 246 poems have melodies extant of which 196 are unica; her study recognizes a total of 315 extant melodies.[119] John Haines counts a total of 322 including melodies found in troubadour manuscripts, trouvère chansonniers, and additional sources.[120] The thematic catalog of troubadour and trouvère melodies compiled by Donna Mayer-Martin and completed by Dorothy Keyser includes the incipits for 317 troubadour melodies identified by unique catalog numbers (M-M 1, etc.).[121] For troubadour song, the catalog includes melodies from the four main sources (*G, R, W,* and *X*) as well as *Delta*, *Cangé*, and *Eta*.[122] Her catalog includes an equivalence of its M-M catalog numbers to those in Pillet and Carsten, as well as contents of the sources and lists of songs by the troubadour they are attributed to. Christelle Chaillou's study, focused on the works of ten troubadours from the fourth generation, includes a

[117] Van der Werf excludes melodies on genre grounds, including melodies categorized as *lais*, *descort*, or *dansa*, as well as several melodies in *W* because they were entered by later hands. Van der Werf, *Extant*, 14-23.
[118] Steel, "Influences," Appendix A and Appendix B.
[119] Stanley Boorman and Elizabeth Aubrey, "Sources, MS.: Ms, III: Secular Monophony: Occitan," *Grove Music Online*, ed. Deane Root, accessed December 26, 2017, http://www.oxfordmusiconline.com; Aubrey, *Music of the Troubadours*, 49.
[120] John Haines, *Eight Centuries of Troubadours and Trouvères: The Changing Identity of Medieval Music* (Cambridge: Cambridge University Press, 2004), 20-21.
[121] 318 troubadour melodies are listed; however, M-M271 and M-M272 both refer to the same melody. The melodies included in this catalog are marked with their identifiers in the edition and study concordance in Appendix B. There is an offline electronic database in the software platform Paradox developed by Dorothy Keyser that was used to organize the data for this project. Keyser gives an overview of this system in Mayer-Martin, *Thematic Catalog*, viii-ix. The incipits were encoded in Finale (MusicXML) for the published edition and were encoded as interval strings in the electronic database. Mayer-Martin, *Thematic Catalog*, ix.
[122] The catalog incorrectly lists Paris, Bibliothèque nationale de France, fr. 125 as a source for one melody, M-M 81 (BEdT 461,122), which is actually found in fr. 12615 (*Delta*). The catalog lists 4,449 trouvère melodies.

table of concordances that lists 314 melodies.[123] There is thus, as observed by Hebbard in her study, no two editions of the melodies which present the same repertory of songs or two studies which recognize an identical corpus.[124]

The choices made by scholars delineating the troubadour repertory can be viewed in many cases as a division between a core and a periphery. The simplest division of the repertory into these two categories is along manuscript lines: the four main manuscripts (*G, R, W,* and *X*, with a few exceptions) constitute the core, while melodies appearing in other sources are considered as a separate group. This approach is that taken by Aubrey, whose study encompasses only melodies from the main four manuscripts and two melodies in *Delta* which have concordances in *W*.[125] Van der Werf includes melodies from both major and minor sources in his transcriptions.[126] Steel explicitly divides the melodies into core and satellite repertoires based (primarily) on their sources, including melodies from *G, R, W,* and *X* and a selection of songs in minor sources (often ones which have concordances within the main manuscripts).[127]

As stated previously, one of the first phases of the encoding project was to access the sources themselves. I collected all available images of the sources, including microfilms, plates in editions and studies, and both print and digital images of sources. Availability of high-

[123] Chaillou, *Faire los motz e-l so*, 53-54. She includes three from *SJA*, two from *Delta*, two from *Cangé*, and one from *Eta*. The two melodies from *Cangé* listed in her concordance are Pistoleta's "Quar eusse je" (BEdT 372,003) and Bernart de Ventadorn's "Tant ai mon cor ple de joja" (BEdT 70,044), the latter of which does not appear with a melody in *Cangé* or other extant sources. She lists two songs with four versions, seventeen with three versions, and thirty-five with two versions. Chaillou, *Faire los motz*, 54. The first two counts agree with those in the TMD for the same group of sources, but the database contains thirty-four songs with two melodies extant. The discrepancy comes from her inclusion in the concordance of an appearance on *R* 64r of a melody for Aimeric de Pegulhan's "En greu pantais ma tengut" (orthography follows *R*) (BEdT 10,027). There is significant ink bleed-through from the verso, but the notes visible on 64r are neither part of a faded melody nor an erasure. The TMD has a third song with four versions which appear in sources not considered by Chaillou, Richard "the Lionheart's" "Ja nuls on pris" (BEdT 420,002).
[124] Hebbard, "Manuscripts," 126-127.
[125] Aubrey, *Music of the Troubadours*, 175.
[126] Van der Werf, *Extant*, 23-24.
[127] Steel, "Influences," Appendix A and Appendix B.

resolution images of these sources was possible in many cases at the beginning of the encoding project in 2015, thanks to mass digitization efforts by the Bibliothèque nationale de France (Gallica) and similar efforts by other major archives, while others were not available until more recently.[128]

Over the course of two archival research trips (2013 and 2017), I examined several of the sources in person to transcribe melodies, take notes on the physical state of the sources, and document erasures and other features of the melodies' current state.[129] In 2013, I worked directly with *G* and *R*; I was also able to view *V* to examine its contents and features in detail. In 2017, I was able to examine several sources with UV to better see details, corrections, erasures, and notes partially obscured through wear (*G*, *R*, and *SJA*). While at the archives, I transcribed the melodies and took notes on the shape of each neume to ensure I had a clear record of both the pitches and the notation.

Encoding Method: Volpiano

As of the implementation of the encoding project (2015-2017), there were several widely-accepted encoding methods available for music. Alphanumerical data was the best choice for the chosen platform, Drupal, a Content-Management Framework, or CMF, which uses a SQL

[128] As of 2019, nearly all troubadour musical sources can be viewed online in reasonably high-quality images, and almost all have images available in color (which was not the case at the beginning of the project in 2013). I still emphasize the importance of consulting historical images of sources as some manuscripts have changed over the past century since facsimiles of the sources first appeared through restoration efforts or the continued damage of time. Digital access to *G* has proved difficult; the site which hosts images for the Biblioteca Ambrosiana has had technical issues for several years. I thus relied on notes from direct consultation of the source, including notes on the notation and marks taken on images from the microfilm available of *G*. A survey of digital images for troubadour manuscripts by Courtney Wells can be found both in his published article (Courtney Joseph Wells, "'Et aysi trobaretz de las suas chansos': Occitan Manuscripts Online," *Tenso* 31, no. 1-2 (Spring-Fall 2016): 69-95.

[129] See the acknowledgements section for a detailed list of the archives visited and the sources of support for my research.

(Structured Query Language) relational database.[130] As a method of encoding that relies on alphanumeric strings, Volpiano was thus the best choice for the project. Further, its ease of encoding, ease of display, and the availability of an existing search tool for Volpiano were all factors in its selection over other available options.

Volpiano is a font which displays alphanumeric strings of characters as stemless black note heads on a five-line staff. It was designed by David Hiley and Fabian Weber of the Institut für Musikwissenschaft of Regensburg University.[131] The most recent version (5, as of 2018) allows a range from f to b''.[132] *Plicas* are encoded with capital letters and are displayed as smaller stemless note heads. The font, designed for chant, has a limited number of accidentals (as of version 5, only those for B-flat, E-flat, and their natural signs), but those were sufficient for the troubadour corpus with two exceptions.[133] Volpiano is not a font in the typical sense, as it is not a typeface that renders letters in a specific style. Instead, it provides a simple method of representing chant notation by pairing the glyphs for each pitch as it appears on a five-line staff to a letter or number in the ASCII character set. It thus functions in the same way as the Wingding font, substituting the usual Latin characters with non-letter glyphs (see Figure 1.2).

[130] For additional information about Drupal, see https://www.drupal.org; for MySQL, see https://www.mysql.com/.
[131] Fabian Weber, "Volpiano." The font is described on the site as is the history of its development. The site also has versions of the font available for download.
[132] Throughout the dissertation, pitch classes appear as capital letters (A, C) and octave-specific pitches are named following the Helmholtz system, with the letter of the pitch with octave indicted through case and the use of apostrophes (a', c'', etc.)
[133] These are in the melodies for "Ar agues eu mil marcs de fin argen" (BEdT 372,003) in *Cangé* and "Pax! in nomine Domini" (BEdT 293,035) in *W*. It is less surprising to find these in trouvère manuscripts than troubadour chansonnier since the trouvère melodies use a wider range of accidentals than that of the troubadour melodies (E-flat, F-sharp, C-sharp, and G-sharp, according to Theodore Karp); on this, see Theodore Karp, "Troubadours, Trouvères: Modality."

Character	Wingding	Volpiano
a	♋	
b	♌	
c	♍	

Figure 1.2: Character comparison

In Volpiano 5, pitches are assigned alphanumeric values starting from f (8), followed by g (9), then the letters a-s.[134] Accidentals are represented by i, w, x, y, and z, which are displayed as flat signs when lowercase and natural signs when uppercase (see Figure 1.3 below). Despite its simplicity, Volpiano encodes not only pitches, but also a considerable amount of information about the notation and the layout of the melodies. It includes the ability to mark line, column, and page breaks (encoded as one to three 7's, displayed as apostrophes).

[134] A key to the font is included as a pdf in the downloadable font files on the Volpiano website (http://fawe.de/volpiano/).

Character	Font	Character	Font
8		j	
9		k	
a		l	
b		m	
c		n	
d		o	
e		p	
f		q	
g		r	
h		s	

Figure 1.3: Volpiano pitch equivalences

Clef signs are entered using 1 or 2 (treble and bass), with 3, 4, and 5 representing different types of bar line. Those symbols mark structural elements of songs (melodic phrases, which typically coincide with poetic lines). Utilizing these features of the font, songs are thus displayed in the database both as they appear in the actual layout of the manuscript and with their melodic phrases aligned to facilitate comparison of melodic relationships between phrases.

The encoding system can also represent the division of notes between words or syllables, so that while not representing the exact shapes of the original notation, it does preserve the number of notes in each neume. Volpiano distinguishes between pitches on the same word (separated by three hyphens), syllable (separated by two hyphens), or separate neumes written over the same syllable (separated by one hyphen). The different data encoded within the melody strings can then be read and processed to generate information about the individual melodies, the corpus as a whole, or about various subgroups within the corpus. For the TMD, the melodies

were encoded to reflect the manuscript readings without editorial corrections to the pitches.[135] Accidentals (encoded as flat and natural signs for pitch classes B and E) are included in the transcriptions only when they are explicitly written in a source, either at the beginning of a staff or before individual notes.

Transcription guidelines

Below, I provide my guidelines and methods for transcribing the melodies encoded in the TMD. Having selected Volpiano for the encoding method prior to beginning the transcribing process, I encoded the melodies directly into Volpiano from the sources (either from images or direct consultation). The following features were included in the transcription itself, derived from the developers' guide to using Volpiano as well as the encoding practices described for chant on the Cantus site, with additions as needed for situations not covered in other guides (such as marginal additions):[136]

- Each pitch as it appears in the source.
- All accidental signs, either at the position it appears in the staff (such as when it appears at a clef change or the beginning of a staff) or next to the note it refers to.
- *Plicas* (encoded as capital letters which appear as smaller note heads in Volpiano).
- All line, page, and column breaks marked with one, two, or three sevens, which appear as ‘ in the transcription in Volpiano
- Notes added in the margin for insertion are surrounded by four 7's (for example, 7777fg77777 marks that "fg" appears in the margin marked as an insertion, rather than being overflow from a line. In Volpiano, this displays as the pitches on the staff with four single apostrophes on each side.
- Missing notes (apparent from the lack of a pitch over a word or syllable or because of visible damage) are marked with <>. They are not supplied based on other similar lines, just left marked as an omission.

[135] XML-based encoding will be able, in the future, to store editorial changes along with the original readings.
[136] The Volpiano font equivalences can be found here: http://www.fawe.de/volpiano/ (accessed 15 November 2019). Cantus's guidelines for Volpiano appear here: http://cantus.uwaterloo.ca/documents (accessed 15 November 2019).

- Musical phrases are divided by a single bar line (3 in Volpiano). The end of a melody is marked with a final barline (5 in Volpiano). If a melody includes the notes of the first line of the second stanza, the end of the melody for the first stanza is marked by the final barline and the end of the first line of the second stanza is marked with a double barline (4). Strophes are also divided by double barlines in the *lais* and *descorts*.
- Words are separated by three dashes (---); syllables by two (--); and pitches over the same syllable in different neumes by one dash (-), though that is rare.

Any pitch whose position on the staff was potentially ambiguous was re-checked and considered in the context of the line (other pitch positions adjacent to the pitch may provide the necessary context through their own position on the staff line or between lines, etc.).

Three versions of the transcribed melodies appear in the TMD: the Volpiano version which is used for the search tool (and the analysis tool); an image of the Volpiano displayed aligned by phrase; and an image of the Volpiano displayed by breaks (line, column, or page) in the source. The additional information gathered during my source research will be incorporated into the site once MEI versions are the melodies are generated, which will allow the incorporation of alternate notes, erasures, and the original neume shapes into the melody records.

Search Functionality in the Troubadour Melodies Database

Connecting the encoded melodies to a searchable interface allows an unprecedented ability to find relationships between them. As mentioned previously, a search tool for Volpiano designed for the Drupal web platform existed prior to this project. The Melody Search Tool is a PHP (Hypertext Preprocessor) and JavaScript-based module designed for Drupal which allows users to search the melodies both at pitch level and in transposition by entering search notes on a five-line interactive staff. Jan Koláček designed it for his digital project, the Global Chant

Database (www.globalchant.org), in 2009. The original Melody Search Tool designed by Koláček transforms the encoded chants into a format that the tool uses to find matches at the beginnings of melodies either at pitch level or any degree of transposition.

The version of the tool seen in the Cantus chant database (http://cantusindex.org/) is dynamic, as matches are displayed live while search notes are entered in the staff without the need to click a "search" button. This search tool was installed on the TMD and served as the basis for the expanded search tool and Melody Analysis Tool described below. The search tool appears in different versions in the Cantus Index and the related Cantus Manuscript Database (http://cantus.uwaterloo.ca). That found in the Cantus Index is an older version of the search tool without any search options (see Figure 1.4):

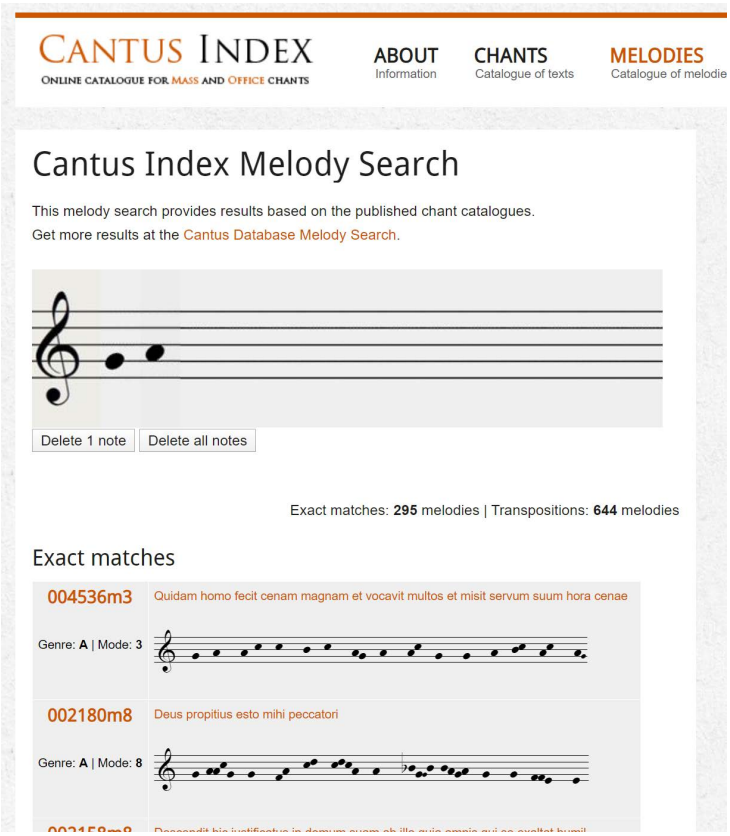


Figure 1.4: Cantus melody search with results (auto-populating) (as of July 2019)

The version of the search tool in the Cantus Manuscript Database is more recent; it includes options to search only the beginning or anywhere in a melody.

With Koláček's permission and the assistance of two programmer consultants at Indiana University, I expanded the search tool in 2016 to permit three search options (beginning, end, and anywhere).[137] In 2017, I added searches for repeated notes at the beginning or anywhere in the melodies. These additional options allow comparison of end-formulas, more specific searches in the case of the ability to find repeated notes, and more broad searches through the 'anywhere' search. The expansion of the tool included reprogramming the PHP code to calculate the numeric values successively from pitch to pitch for the transposition searches, creating interval profiles of each melody.[138] This allowed greater search flexibility while also providing additional data about the melodies.

Analysis Extension of Search Code: The Melody Analysis Tool

To date, Volpiano has been used mainly to visually represent and to search melodies. According to the description on its source site in 2017: "It was designed principally for use in databases and inventories, since melodies notated with Volpiano can be sorted and searched

[137] The IU programmers are Adam Hochstetter and Guangchen Ruan.
[138] The calculation used for the chromatic interval conversion in the expanded Melody Search Tool backend follows Koláček's use of interval-invariancy in the original tool to ensure all intervals are calculated as the same integer (in encoding systems that do not account for this, which have interval-variancy, the same interval (minor 2nd, etc.) may be represented by different integers when calculated from notes that involve accidentals). A discussion of these two types of approaches and their history of use in music encoding can be found in Walter B. Hewlett, "A Base-40 Number-line Representation of Musical Pitch Notation," http://www.ccarh.org/publications/reprints/base40/ (originally published: *Musikometrika* 4 (1992): 1-14.

'alphabetically.'"[139] However, it is not only limited to these functions. Volpiano-encoded data can also be analyzed to generate the main characteristics of the corpus. From the starting point of the melodies as text-strings, I designed the Melody Analysis Tool to extract features from the melodies regarding their pitch and interval content, as well as some aspects of their neumatic content and structure. [140]

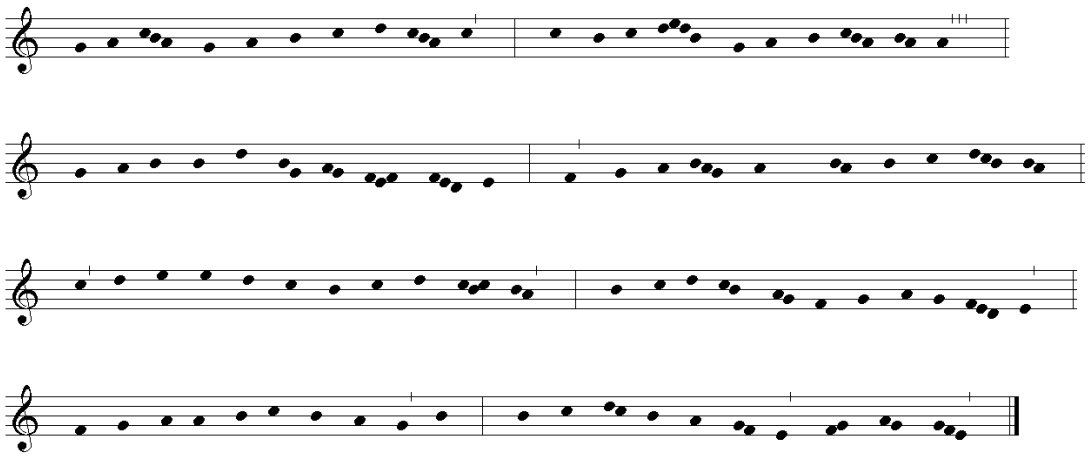
The output of the Melody Analysis Tool is demonstrated below using the melody of Aimeric de Pegulhan's *canso* "Atressi·m pren com fai al jogador" (BEdT 10,012). The melody is displayed first as an alphanumeric string and secondly as displayed with Volpiano:

1---g--h--kjh---g---h---j---k---l--kjh--k7---3---k---j--k--lmlj---g--h---j--kjh--jh--h777---3

1---g---h--j---j---l---jg--hg--fef---fed--e---3---f7---g---h--jhg---h------jh---j---k---lkj--jh---3

1---k7--l---m---m---l---k---j---k---l---kjk--jh7---3---j---k--l--kj---hg--f---g---h--g--fed--e7---3

1---f---g---h--h---j--k---j---h---g7--j---3---j---k---lk--j---h---gf--e7---fg---hg---gfe7---5



Music Example 1.1: "Atressi·m pren com fai" as alphanumeric string and in Volpiano

[139] Weber, "Volpiano," http://www.uni-regensburg.de/Fakultaeten/phil_Fak_I/Musikwissenschaft/cantus/volpiano.html (accessed 11 December 2016). Now located at: http://www.fawe.de/volpiano/ (accessed 7 December 2017).

[140] See Appendix C for the Melody Analysis Tool Description, which lists all of the features the tool extracts.

From the encoded melody above, the Melody Analysis Tool extracts the following selected characteristics of the melody (see figures 5-8: for intervals, “M” identifies a major interval, “m” a minor interval, + an ascending interval, - a descending interval, and U is a unison):

First	Last	Highest	Lowest	Range	Range	Range with Quality	First Interval	Last Interval
					9th	M9	M2+	m2-
Bounding Notes				**Cadential Intervals**		**Cadential Pitches**		
				U, M2-, m2-				

Figure 1.5: Melody characteristics for “Atressi·m pren com fai”

Total Pitches										
117	0	0	0	0	2	2	7	10	17	23
										
	0	26	19	10	3	0	0	0	0	0

Figure 1.6: Pitch counts for “Atressi·m pren com fai”

	Descending																
Total Intervals	**m 11**	**M 10**	**m 10**	**M 9**	**m 9**	**P8**	**M 7**	**m7**	**M 6**	**m 6**	**P5**	**Tritone**	**P4**	**M 3**	**m 3**	**M 2**	**m 2**
116	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	34	13
	Ascending																
Unison	**m 11**	**M 10**	**m 10**	**M 9**	**m 9**	**P8**	**M 7**	**m7**	**M 6**	**m 6**	**P5**	**Tritone**	**P4**	**M 3**	**m 3**	**M 2**	**m 2**
9	0	0	0	0	0	0	0	0	0	0	0	0	1	4	34	13	0

Figure 1.7: Interval counts in "Atressi·m pren com fai"

Total Neumes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Average Pitches per Neume**
82	59	12	10	1	0	0	0	0	0	0	0	0	1.427

Figure 1.8: Neume counts for "Atressi·m pren com fai"

For each melody, the Melody Analysis Tool also creates an interval profile with quality and direction and a list of all the unique intervals that appear in each melody. The interval profile for the same melody ("Atressi·m pren com fai") follows, given as numeric values (+ means an ascending interval, - a descending interval, and U is a unison):

+2,+3,-1,-2,-2,+2,+2,+1,+2,-2,-1,-2,+3,+0,-1,+1,+2,+2,-2,-3,-4,+2,+2,+1,-1,-2,+2,-2,+0,
-2,+2,+2,+0,+3,-3,-4,+2,-2,-2,-1,+1,+0,-1,-2,+2,+1,+2,+2,+2,-2,-2,+2,+2,-2,+2,+1,+2,-2,
-1,+0,-2,+3,+2,+2,+0,-2,-2,-1,+1,+2,-2,-1,+1,-1,-2,+2,+1,+2,-2,-1,-2,-2,-2,+2,+2,-2,-2,-1,
-2,+2,+1,+2,+2,+0,+2,+1,-1,-2,-2,+4,+0,+1,+2,-2,-1,-2,-2,-2,-1,+1,+2,+2,-2,+0,-2,-1

as interval names ("M" represents major quality and "m" represents minor quality):

M2+,m3+,m2-,M2-,M2-,M2+,M2+,m2+,M2+,M2-,m2-,M2-,m3+,_U_,m2-,
m2+,M2+,M2+,M2-,m3-,M3-,M2+,M2+,m2+,m2-,M2-,M2+,M2-,_U_,M2-,
M2+,M2+,_U_,m3+,m3-,M3-,M2+,M2-,M2-,m2-,m2+,_U_,m2-,M2-, M2+,

m2+,M2+,M2+,M2+,M2-,M2-,M2+,M2+,M2-,M2+,m2+,M2+,M2-,m2-,_U_,

M2-, m3+,M2+,M2+,_U_,M2-,M2-,m2-,m2+,M2+,M2-,m2-,m2+,m2-,M2-,
M2+,m2+,M2+,M2-,m2-,M2-,M2-,M2-,M2+,M2+,M2-,M2-,m2-,M2-,M2+,
m2+,M2+,M2+,_U_,M2+,m2+,m2-,M2-,M2-,M3+,_U_,m2+,M2+,M2-,m2-,M2-,

M2-,M2-,m2-,m2+,M2+,M2+,M2-,_U_,M2-,m2-

and as a set of unique intervals found in the melody:

M3-:m3-:M2-:m2-:_U_:m2+:M2+:m3+:M3+

These processed versions of the melodies thus provide several levels at which the repertory can be compared, including not only similarities in their successive pitch or intervallic structure, but also of their general pitch or intervallic content through the interval and pitch sets.

With the troubadour melodies encoded, musical connections within the corpus can be located using statistical and machine methods previously unavailable. For this project, I analyzed the encoded melodies themselves, the set of reference characteristics generated by the Melody Analysis Tool, the interval profiles, and other transformations of the melodies. Based on these data sets, the repertory can be compared for various levels of interconnection as well as stylistic trends within an individual troubadour's output, a generation, or genre. Further, these computational approaches make it possible to trace potential influences between melodies at both pitch level and in transposition, which is more difficult to perceive through traditional methods of analysis.

Pitch and Interval Analysis

Once these datasets of musical characteristics were available, I examined the musical traits of the repertory in search of patterns and trends both across the tradition as a whole and within subgroups, such as genre, troubadour, or troubadour generation (to the extent that is possible with the asymmetry of the tradition across some of those divisions). Consideration of initial and final pitches, ambitus, and other melodic features provides context for the assessment of the structure of individual melodies by establishing which pitches, intervals, etc., appear most often in the corpus and where they appear within melodic structures. The melodic contour of the corpus is another characteristic more readily analyzed with the melodies encoded, as it is fairly simple to transform the interval profiles of the melodies into versions which focus on direction of motion or interval size. Like pitch usage, interval frequency can be used to compare stylistic trends between troubadours, genres, and generations, and can contextualize which intervals are exceptional when they appear in the corpus. When analyzed at a more granular level, the data can show tendencies of particular troubadours, generations, etc. Patterns can then be sought, or research questions suggested: where do the more infrequent intervals appear most often? Why are ascending tritones so much more common than descending ones, and why are both types of tritone more common than their corresponding minor sixth? The manner in which large leaps are typically approached and left can also be compared using the interval profiles by employing the methods described below.

Digital and Computational Text Analysis Tools

Chapter II utilizes methods drawn from corpus linguistics, also known as computational linguistics. Approaches used for the "distant reading" of literary works are used to analyze and compare melodies in this project.[141] Digital humanist and literary scholar Matthew Jockers describes the position and contribution of computational approaches in his introduction to text analysis as follows:

> When discussing my work as a computing humanist, I am frequently asked whether the methods and approaches I advocate succeed in bringing new knowledge to our study of literature. My answer is strong and resounding yes. At the same time, that strong yes must be qualified a bit; not everything that text analysis reveals is a breakthrough discovery. A good deal of computational work is specifically aimed at testing, rejecting, or reconfirming the knowledge that we think we already possess.
>
> My point…was not to pretend that I had discovered something new about the position of the novel in the American literary tradition, but rather to bring a new type of evidence and a new perspective to the matter and in so doing fortify (in this case) the existing hypothesis.[142]

Jockers's perspective here points to the usefulness of digital analysis and computational approaches at refining our understanding of the research subject by examining it through the lens of big data, statistical analysis, and quantitative approaches. These methods provide data which can sometimes lead to new knowledge, but always adds to or refines our understanding of the corpus studied. Like the nineteenth-century corpus described in Franco Moretti's research, the

[141] Moretti, *Distant Reading*, 6.

[142] Matthew L. Jockers, *Text Analysis with R for Students of Literature* (New York: Springer International Publishing, 2014), vii-viii. For further reading on the methods and applications of text analysis, see Stéfan Sinclair and Geoffrey Rockwell, "Text Analysis and Visualization: Making Meaning Count," in *A New Companion to Digital Humanities*, ed. Susan Schreibman, Ray Siemens, and John Unsworth, 330-349 (Malden, MA: John Wiley & Sons, Ltd., 2016). The authors explain one of the main contributions of computational linguistics thusly: "For texts with which I am already familiar, how can computers help me identify and study interesting things I had not noticed before, or things I had noticed but did not have reasonable means to pursue? Digital texts enable a proliferation of representations to explore linguistic and semantic characteristics and produce new representations and new associations, all of which can help to solidify intuitions we may already have had or generate entirely new perspectives." Sinclair and Rockwell, "Text Analysis," 339.

surviving troubadour corpus is not the whole of what existed; further, because of the variability of transmission and differences in approach to originality and authorship in the medieval period, the songs do not exist in a printed, edited, and published format. Despite differences in the type of material and corpus size, the analytical approaches developed for distant reading are valuable tools for the repertory, such as those used for statistical analysis of corpora. This same principal is noted by Helen Deeming and Elizabeth Eva Leach in their discussion of song in medieval sources:

> Whether they [manuscripts] display thoroughgoing anthologizing principles or not, however, all manuscripts containing song came about as the result of a gathering process in which a wider stock is implied. For each song chosen for inclusion in one of these witnesses, a much greater number must have been left out, and while we can speculate – sometimes quite confidently – about the reasons why some songs were included in them, we cannot know on what grounds other songs, unknown to us, were omitted.[143]

This perspective thus echoes the concept of the "great unread" found discussed in corpus linguistics and the importance of gleaning every drop of information possible from the sources that have survived.

The fact that the melodies are encoded using alphanumeric strings in Volpiano allows the melodies to be analyzed by existing text mining and statistical analysis software programs such as AntConc.[144] These tools calculate and compare word lists, concordances, collocates (finding specified words located near each other), and allow identification of similarities that help

[143] Helen Deeming and Elizabeth Eva Leach, eds., *Manuscripts and Medieval Song: Inscription, Performance, Context* (Cambridge: Cambridge University Press, 2015), 284.
[144] AntConc is a corpus analysis tool designed by Laurence Anthony. The software is available here: http://www.laurenceanthony.net/software/antconc/ (accessed 1 September 2019).

determine relationships between works.[145] One of the easiest analysis tools to use, AntConc, requires no knowledge of coding by the user; thus, nearly anyone can use the program to examine a corpus of melodies encoded in Volpiano. User-directed searches of the corpus can also be conducted to find specific motives or to compare specific melodies; the advantage of the methods described here are that they can identify all melodic patterns shared by two or more songs across the entire corpus rather than relying on the output of individual manual searches. Results from these methods must then be contextualized within the historical knowledge and/or poetic structure of the work to determine if the identified related material between melodies has significance.

Tracing concordances is an approach common to both textual and musical scholarship; the encoded transcriptions allow for concordances to be easily generated by statistical analysis programs. An example of a 'word list' of pitches and pitchgroups from the melodies encoded as Volpiano alphanumeric strings in the analysis program AntConc appears below (see Figure 1.9), showing each pitch or note group from the melodies with the frequency of each one's appearance:

[145] Michael Cuthbert's 2017 plugin for Volpiano that converts it into a format readable by his Music21 program also creates new opportunities to analyze melodies encoded in Volpiano using his interface. https://web.mit.edu/music21/ (accessed 1 September 2019).

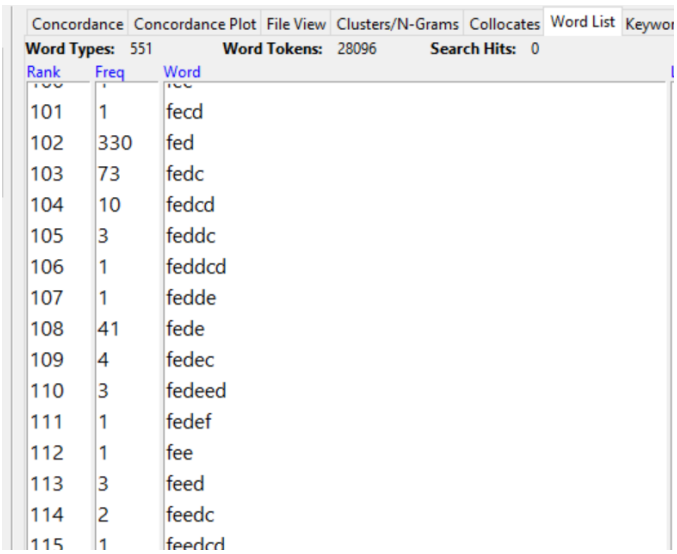


Figure 1.9: Wordlist in AntConc from encoded melodies

I then used AntConc to show both concordances and concordance plots (discussed below) for each pitch and pitch group in the corpus. Figure 1.10 shows an excerpt of the concordances for g'f'g':

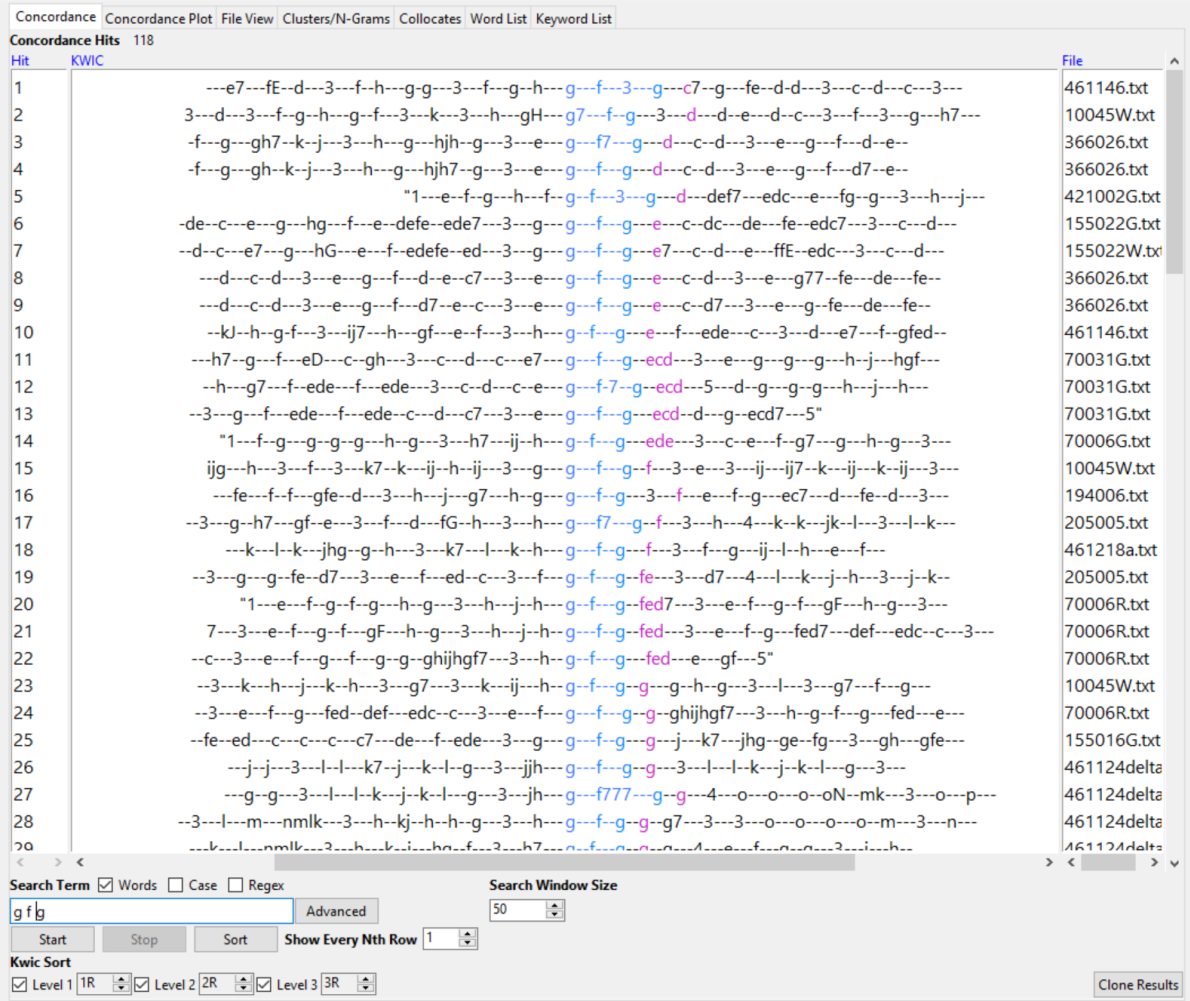


Figure 1.10: Concordance of encoded melodies in AntConc (excerpt)

The concordances feature can also be used to examine the interval profiles instead of specific pitch patterns for the encoded melodies. This allows for comparison of the intervallic content (or other transformations) of the melodies in the same manner as the pitches.

One useful visualization is the concordance plot, also known as the distribution plot (see Figure 1.11). This allows the position of pitch or interval segments to be marked where they appear in each melody for comparison from the search results. For example, the pitch pattern a'g'f'e'd' appears twenty-four times in the entire corpus. Lengths of individual melodies differ

but are equalized in these representations so that the position of motives within the overall structure are easier to compare (the total number of units, either pitches or note groups, is included in the plot).

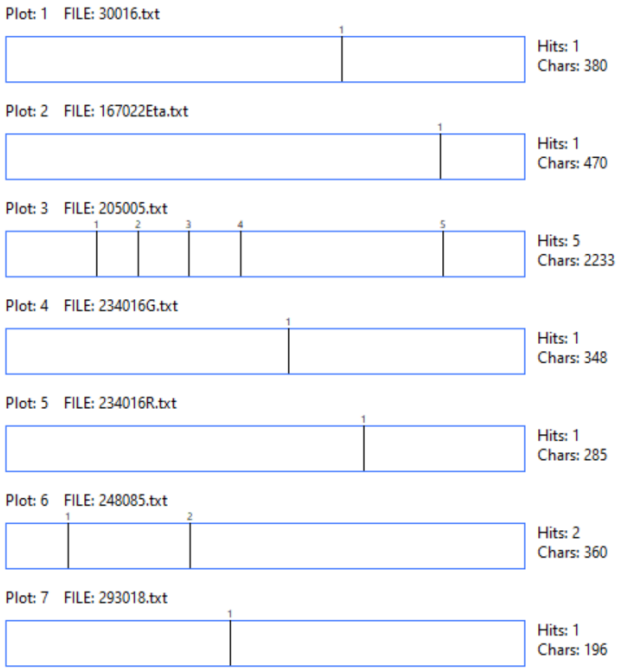


Figure 1.11: Distribution plots of a'g'f'e'd' (excerpt)

These plots thus allow for ease of comparison of motivic material between melodies, as well as providing a simple method to see how motives are positioned within a particular melody when

they are repeated. For example, in Peirol's "Perdan qe damor mauegna" (BEdT 366,026), the motive g' f' g' appears four times at regular intervals:

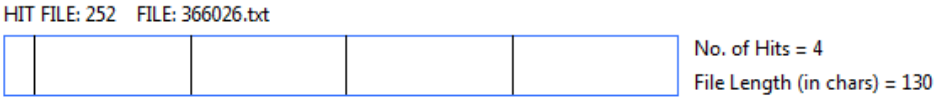
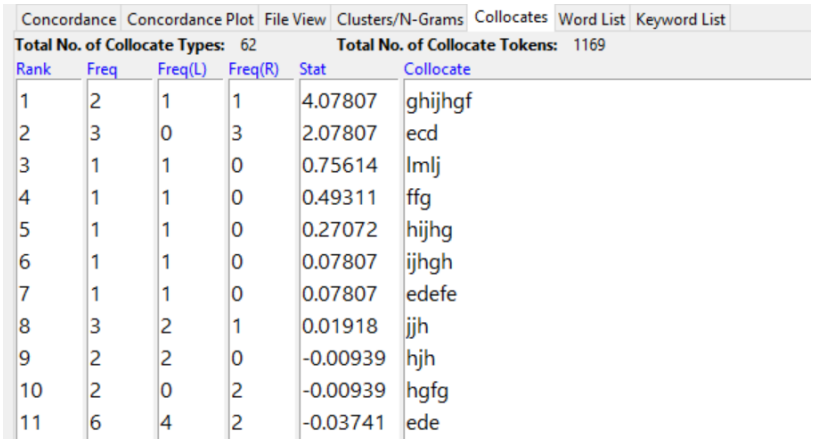


Figure 1.12: Distribution plot of g' f 'g' in "Perdan qe damor mauegna"

The regular spacing of the motive throughout the work is a result of not only the repetition of melodic phrases in the melody (ABABCDCD'), but also of a motivic connection between phrase A and phrase C, as both phrases include this motive near the beginning of the phrase.

Collocates are 'words' found located near each other within specified parameters. A particular musical motive that appears within three neumes of another motive would be an example of a collocate search for matches within three 'words' of the search term. Such searches can thus return both sequential and non-sequential patterns; the latter is particularly useful as there is not currently a fuzzy search option for the melody search. Figure 1.13 shows an excerpt of the collocate results for g'f'g' for a search for motives that appear within five 'words' to the left or right of the motive:



Concordance | Concordance Plot | File View | Clusters/N-Grams | Collocates | Word List | Keyword List

Total No. of Collocate Types: 62 **Total No. of Collocate Tokens:** 1169

Rank	Freq	Freq(L)	Freq(R)	Stat	Collocate
1	2	1	1	4.07807	ghijhgf
2	3	0	3	2.07807	ecd
3	1	1	0	0.75614	lmlj
4	1	1	0	0.49311	ffg
5	1	1	0	0.27072	hijhg
6	1	1	0	0.07807	ijhgh
7	1	1	0	0.07807	edefe
8	3	2	1	0.01918	jjh
9	2	2	0	-0.00939	hjh
10	2	0	2	-0.00939	hgfg
11	6	4	2	-0.03741	ede

Figure 1.13: Collocates result from encoded melodies (excerpt)

From these results, the specific notes or note groups can be selected and their concordances individually browsed to view their specific context in detail (see Figure 1.14).

Figure 1.14: Concordances of g' f'g' collocates

These kinds of searches thus permit greater search flexibility than a purely sequential search. When looking for melodic variations or influences, the ability to find low-level connections

through shifting motives or pitches is useful, particularly because of the necessity of altering placement of notes to accommodate shifting accents and syllable numbers between lines.

Another approach to analysis of Volpiano-encoded melodies relies on LSA (Latent Semantic Analysis), which compares the similarity of documents, generating values which can then be used to visualize relationships between documents within a corpus. When LSA is run on the encoded melodies, one option is the creation of a similarity matrix which gives the cosine similarity score of each song to all of the others (the same approach can be taken with the interval profiles or with the texts). The similarity matrix can then be used to generate visualizations which help identify relationships between songs, such as using a color scale to turn the matrix in a heat map (using color to show the degree of similarity). The matrix can also be used to find the most and least statistically similar melodies for each song, using a distant reading approach to focus attention on which melodies should be compared through close reading. Application of this approach to the melodies is thus useful not only in the possibilities for finding connections between works, but also in comparing melodies which have multiple manuscript appearances. For example, Gaucelm Faidit's "Fortz cauza es que tot lo major dan" (BEdT 167,022) appears in four manuscripts (three of the main sources, *G/W/X*, and one minor source, *Eta*. An excerpt of the similarity matrix appears below which compares each version of the melody to the other three, with "n/a" where the melody would be compared to itself (see Figure 1.15).

	167022Eta	167022G	167022W	167022X
167022Eta	n/a	0.844	0.807	0.801
167022G	0.844	n/a	0.768	0.840
167022W	0.807	0.768	n/a	0.800
167022X	0.801	0.840	0.800	n/a

Figure 1.15: Statistical similarity of "Fortz cauza es"

From this comparison, the versions of the melody in *G* and *Eta* are the closest of the four, with a similarity score of 0.844, followed by the versions in *G* and *X* with a score of 0.841. The version of the melody in *W*, however, is less similar to the other two versions, but is more similar to the versions in *Eta* and *X* than that in *G*.

Textual analysis tools thus allow several different methods to find characteristics of the encoded melodies, either by applying them to the melodies themselves or to the musical features generated by the Melody Analysis Tool. The corpus comparison tools are particularly useful at identifying and quantifying appearances of different features, either drawn from the melodies (counting each pitch or motive appearance, for example) or from the musical characteristics themselves (ranges, boundary notes, etc.). These tools thus permit a range of types of analysis, while also building on the results of pitch and interval analysis of the melodies by allowing the musical features themselves to be analyzed and compared statistically.

The datasets used in this dissertation are available in the TMD.

Characteristics of Main Musical Sources

A detailed demonstration of the Melody Analysis Tool's data output and its application to the discussion of troubadour song appears below. I draw on musical features extracted from the encoded melodies with the Melody Analysis Tool to compare the musical characteristics of the four main musical sources (*G, R, W,* and *X*).[146] These four sources were made in three of the four geographical areas where troubadour manuscript production took place during the mid-twelfth through the early thirteenth century (Northern France, Occitania, and Italy); together, they contain ninety-four percent of the extant melodies. The series of figures below compare the boundary pitches of each melody (first, last, highest, and lowest notes) found in the four manuscripts. The figures represent the pitches found in *G, R, W,* and *X* as one hundred percent of appearances for all songs in each manuscript rather than number of melodies in each source. For first note appearances (see Figure 1.16), the sources share a similar division in appearances for a majority of notes. Exceptions to this are that f'' appears most often in the Old French sources (*W* and *X*); g'' appears only in *R*; and a (the second-lowest pitch found in troubadour song) appears as an initial pitch only in *W*. Disparity in the number of melodies in each source requires that their musical features be compared as percentages rather than by the simple totals of their musical features.[147]

[146] Steel compares the ambitus of melodies by manuscript in addition to text-setting styles and interval use.
[147] A tabulation of the contents of the music manuscripts is available in the TMD.

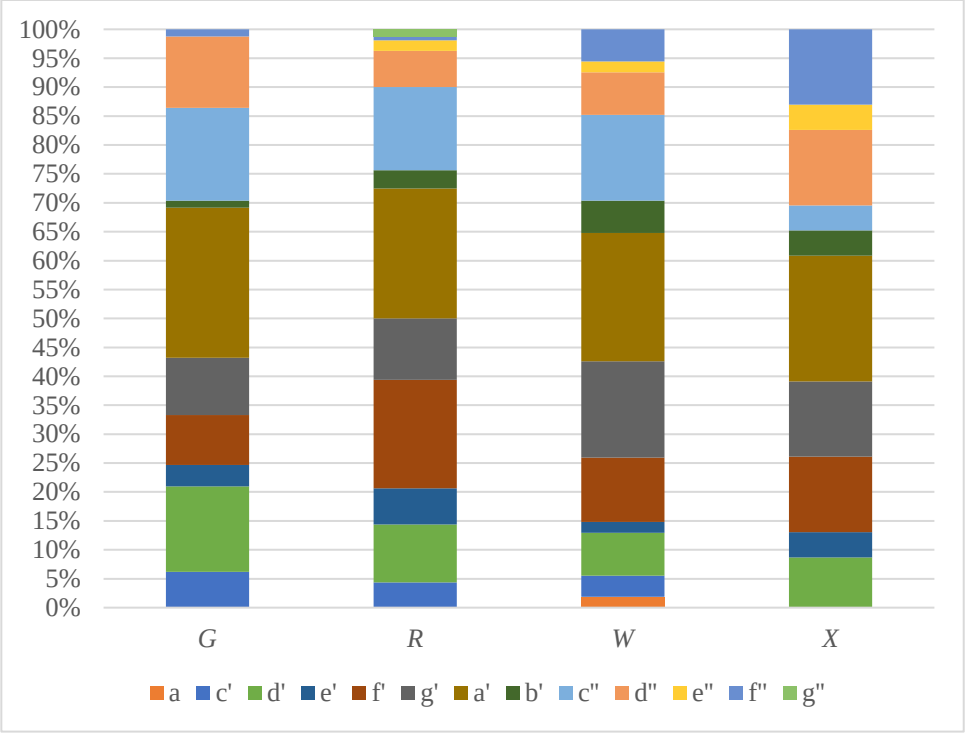


Figure 1.16: First notes in G, R, W, and X

The most common initial pitch is a', which appears as the first pitch of twenty to twenty-five percent of the melodies in each source; the next most common are d', f', and g'. *W* has the largest range of first pitches (spanning a thirteenth from a-f''), while *X* has the smallest (ranging a tenth from d'-f''). *G* and *R* have the most similarity in their first notes, showing a similar division of the pitches appearing as first notes overall. *X* has the most noticeable differences from the other manuscripts: it does not have any melodies with a as a first pitch; it has a higher percentage of f' compared to the other sources; and it is the only manuscript with greater than thirty percent of its melodies beginning on a pitch above c''.

Like the initial pitches, final pitches in troubadour melodies (see Figure 1.17) also overlap in the most common pitches in sources. *G* and *R* include nine different final pitches,

while *X* has six and *W* seven. The most frequent final pitches overall are d', g', and c'. Pitches higher than c'' are uncommon as final notes in all sources; the highest final is found in *R* (e''), while the lowest is found in *G* (a).

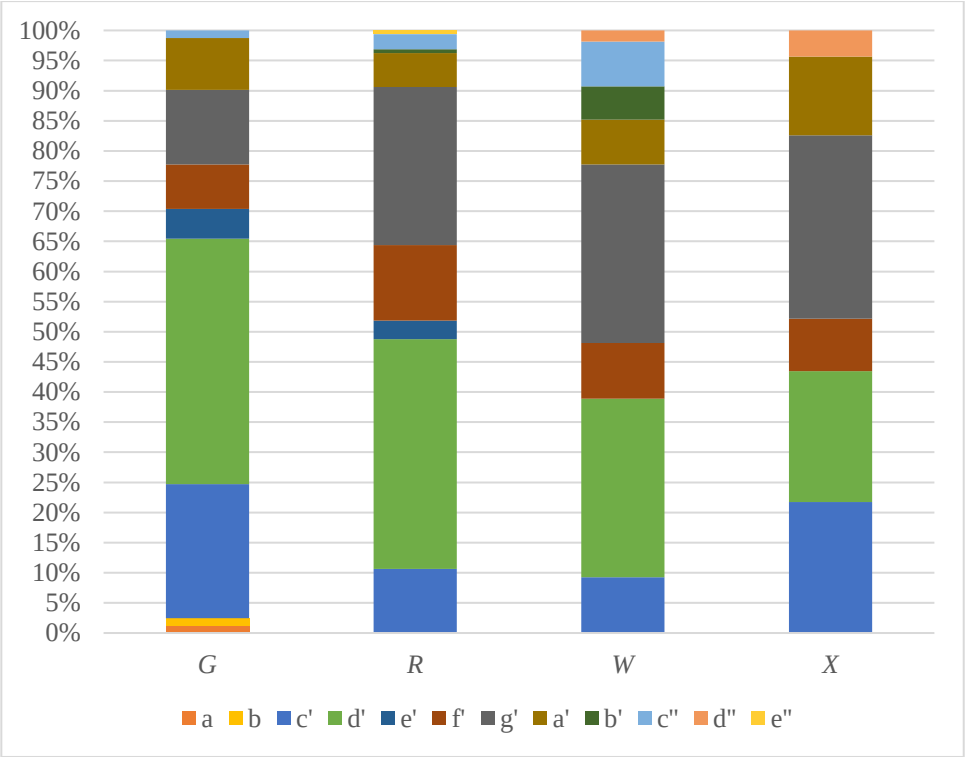


Figure 1.17: Last notes in G, R, W, and X

A final pitch on b' occurs only in *W* and *R*, with one appearance in the repertory of b as a final pitch (in *G*). E final pitches are found only in *G* and *R*, with the higher octave e'' appearing only once as a final pitch in *R* only. The figure above demonstrates the rarity of final pitches from the edges of the range used in troubadour melodies, with eighty to ninety percent of final notes falling in the range c'-g'. No final pitches in the corpus are altered with an accidental, but there are examples of altered highest pitches, discussed below.

The rate of appearance for highest pitches in these four sources has a clearer distinction between *W/X* and *G/R* than for first or final notes. Four pitches appear in *G* and *R* as the uppermost note of a melody that do not appear as such in *W* and *X* (g'-c''). The pitch g'' appears at a higher rate of frequency in *W* and *X* than the other two sources, while e'' is more common in *G* and *R*.

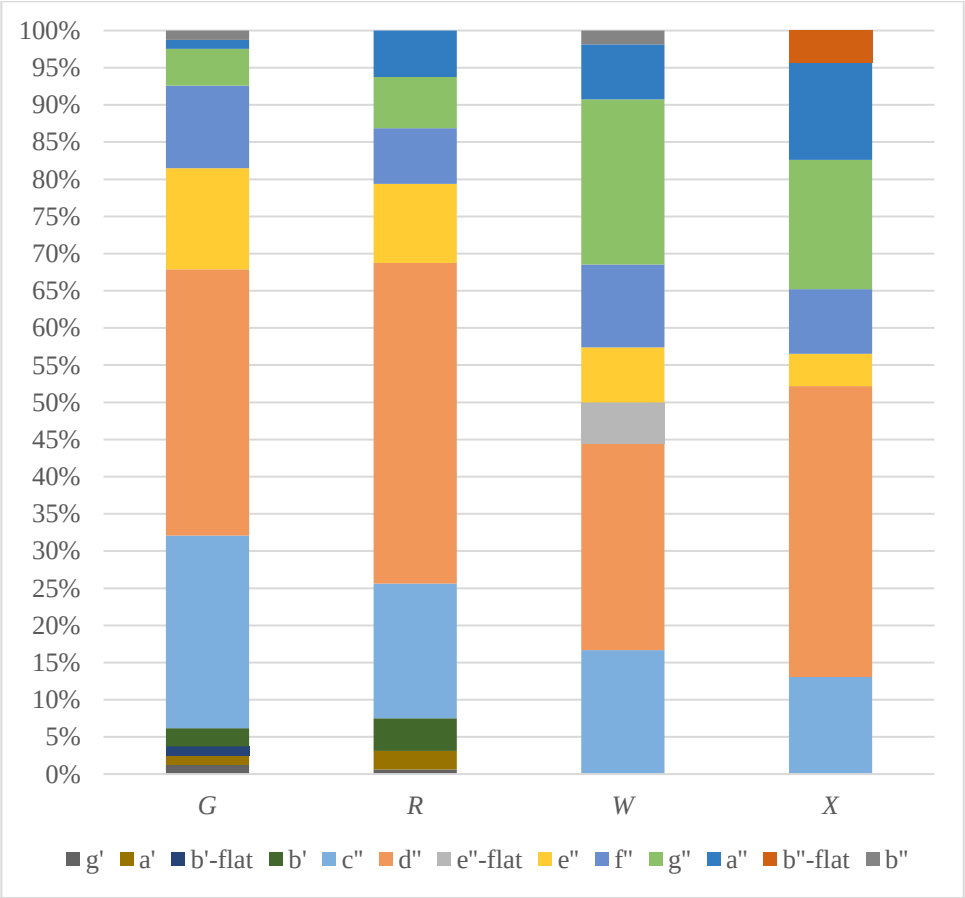


Figure 1.18: Highest notes in G, R, W, and X

The most common highest pitches are c'' and d'', with c'' appearing in twelve to twenty-five percent of melodies in each source, and d'' appearing in twenty-five to forty-five percent of each source's melodies. Among the four sources, *G* and *R* have the most in common for highest notes, sharing similar percentages for the five pitches (c''-g'') that together account for ninety percent of highest pitches in those two sources. *G* and *R* both use g'' about half as often as in *W/X*. Altered pitches appear as the highest note in three of the sources: *G* (b'-flat), *W* (e''-flat), and *X* (b''-flat). *W* and *X* have the smallest range of highest pitches, both spanning a seventh, while *G* spans an eleventh and *R* a tenth. There is thus a noticeable difference in the rates of appearance of highest pitches between the Old French and Occitan chansonniers.

The lowest notes for each melody in the repertory show the least consistency of the four boundary pitches. Although c' is the most frequently appearing lowest pitch in all sources, it is not evenly distributed; about seventy percent of the melodies in *R*, fifty percent in *G*, and twenty to thirty percent in *W/X* descend to c' (see Figure 1.19).

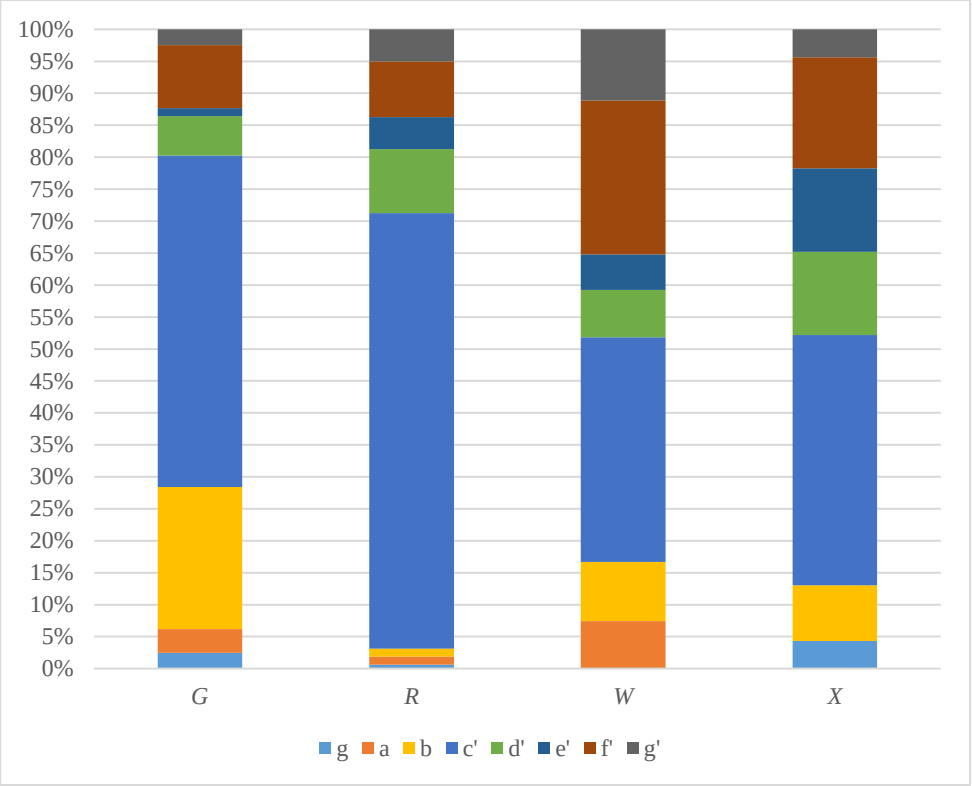


Figure 1.19: Lowest pitches in G, R, W, and X

As with the highest pitches, the two most similar manuscripts here are *W* and *X*, but to a lesser degree. *W/X* have more appearances of f' than found in *G/R*; *W* has the most appearances of g' overall. The lowest pitch is also the only one of the boundary notes in which B has a significant presence in either octave. With respect to the four boundary notes' appearances in the four main sources, there are several features which stand out overall. In general, the two Old French chansonniers (*W* and *X*) share more commonalities than they do with the Occitan ones (*G* and *R*). *G* and *R* are most similar in their use of highest pitches. Final pitches have the most similar rate of appearance in all four sources for any of the boundary notes. The manuscript which tends to have the most differences from the other three overall is *X*, although the degree of difference is not always substantial.

The ambitus of melodies in the main sources spans from a minor sixth to a major fourteenth; most stay between an octave and a minor eleventh. The percentage of each source's melodies with a particular range appears in Figure 1.20 (a capital 'M' denotes a major interval and 'm' a minor interval).

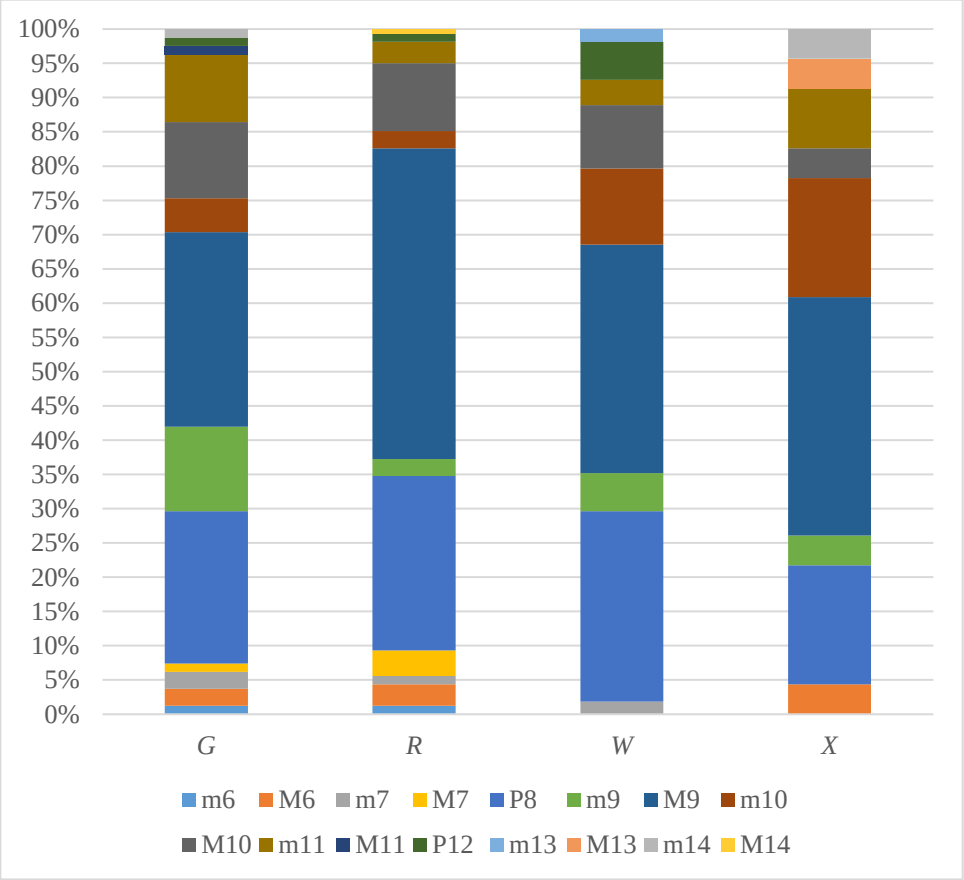


Figure 1.20: Range intervals with quality in G, R, W and X

Several intervals are common (or uncommon) regardless of quality, like sixths and sevenths, while others are more common in their major form or vice versa. Minor ninth ranges are much less common in all four sources than major ninths. Minor tenths are less frequent than major tenths in *G/R* but the reverse is true in *W/X*. The few cases where a melody spans a thirteenth are

found in the two trouvère sources, *W* and *X*, while the four smallest ranges are only all found in the Occitan chansonniers. The distribution of ranges is even more clearly compared across these sources as intervals without quality (see Figure 1.21). Eighty percent of the ranges in all four sources are an octave, ninth, or tenth:

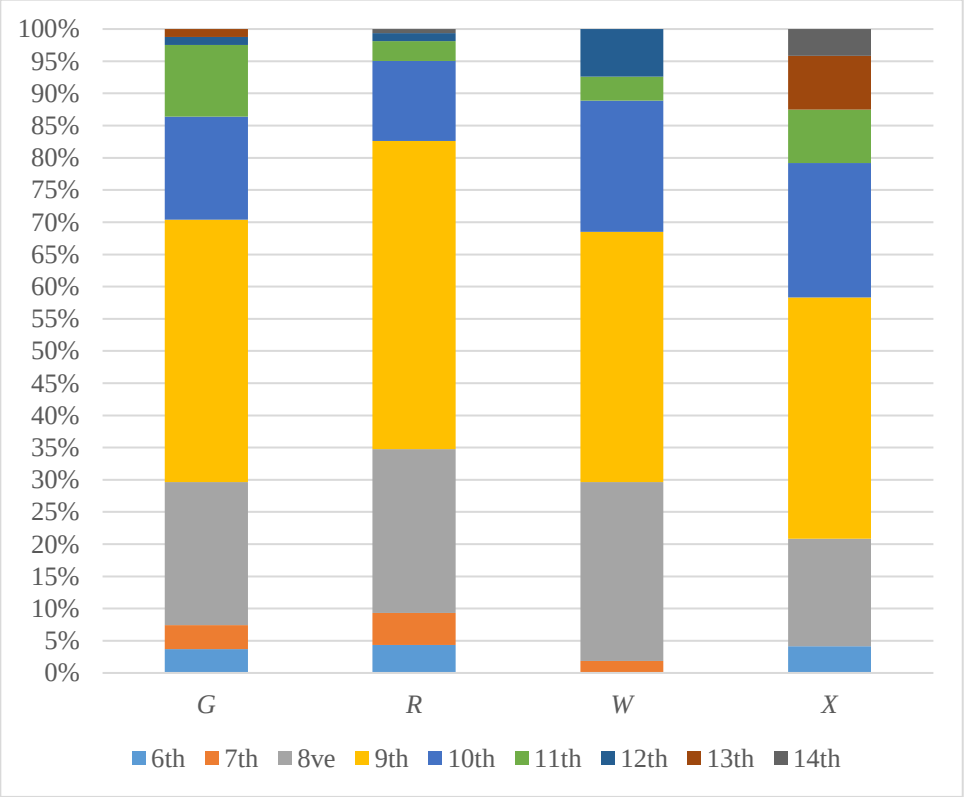
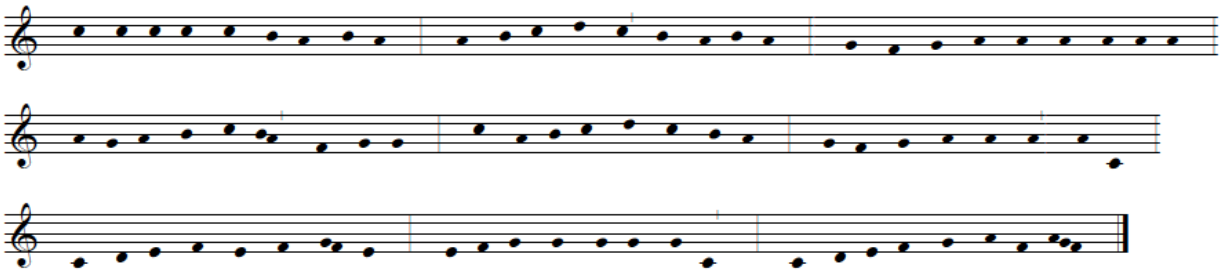


Figure 1.21: Range intervals in G, R, W and X

W has the fewest different range intervals. All of its troubadour melodies span between a seventh and a twelfth. The largest range in the corpus, a fourteenth, appears in both *G* and *X*. *X* has the highest percentage overall of ranges above a twelfth. The simplified range division makes the similarities between the sources more distinct, stressing the significant majority of melodies with

a range of an octave to a tenth and the very small number of melodies which have the smallest or largest ranges found in the repertory.

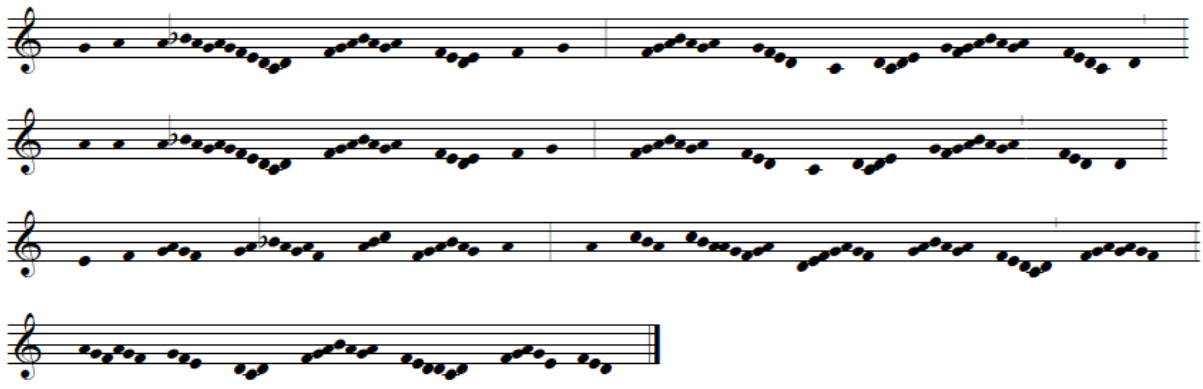
After analyzing the pitchscape of the melodies, I compared the four main manuscripts based on the average number of pitches per neume (PPN) of their melodies to establish the extent to which melodies in each source are syllabic or melismatic. This parameter is calculated by dividing the number of pitches in a melody by the number of neumes.[148] Songs with an average near one are syllabic overall, while songs with higher averages contain more multi-pitch neumes and are thus considered neumatic or melismatic. The most syllabic melody in the corpus is attributed to the Monk of Montaudon, "Mot menueya soauzes dire" (BEdT 305,010), with an average pitch per neume value of 1.053:



Music Example 1.2: Melody for the Monk of Montaudon's "Mot menueya soauzes dire"

The most melismatic melody in the repertory, Guiraut Riquier's "Jhesus Cristz, fills de Deu viu" (BEdT 248,046), has a PPN of 4.102.[149] As seen in Music Example 1.3 below, the melody is melismatic nearly throughout, with zero to four syllabic notes and multiple melismas per phrase:

[148] In nearly all cases, this is equivalent to the number of pitches per syllable as well.
[149] This melody is discussed in detail in Chapter II, Case Study 1.



Music Example 1.3: Melody for Guiraut Riquier's "Jhesus Cristz"

"Jhesus Cristz" is significantly more melismatic than the next closest melody, also by Riquier, which has a PPN of 2.75.[150] The majority of the melodies in the corpus fall between 1.2-1.9 pitches per neume, pointing to the extent of the impact of Riquier's melodies on the musical style of *R* overall.

When the four main sources are compared using this type of calculation, certain trends are evident. *R* has the widest range of PPN values, largely because of the presence of Guiraut Riquier's melodies. Figure 1.22 shows the average of each source's PPN values as well as the lowest and highest PPNs found in each source. The average for *R* is given for both all melodies in the source and all melodies except for those of Riquier to show the statistical impact of his melodies on computations for that manuscript.

[150] "Qui·s tolgues" (BEdT 248,069). Like "Jhesus Cristz," this melody also has few syllabic notes and multiple melismas per phrase, but the melismas are typically around five pitches each instead of the lengthier ones seen in "Jhesus Cristz."

Ms	**Average PPN**	**Lowest PPN**	**Highest PPN**
G	1.53	1.14	2.24
R	1.67	1.05	4.10
R (w/o Riquier)	1.51	1.05	2.57
W	1.61	1.06	2.27
X	1.63	1.16	2.55

Figure 1.22: PPN in G, R, W and X

Riquier's melodies alone have an average PPN of 2.09, significantly higher than that found in any of the sources. Removing his melodies from the computations thus significantly alters the number of very melismatic melodies in *R*, most noticeable in the change to *R*'s highest PPN value. The four sources have similar lowest PPNs (*G/R* and *W/X* have almost identical values to each other); this demonstrates that the most syllabic songs in each of the four sources are similar to each other in this respect. *R* and *X* have the most melismatic melodies of the four sources with Riquier included in *R*'s average; without Riquier, *R* becomes the least melismatic source statistically. The two French sources have nearly identical PPN averages, while the two Occitan sources are equally similar to each other when compared without the melodies by Riquier.

The final aspect of musical style compared is the length of the melodies, measured here by the number of musical phrases in each song (which is usually the same as the number of lines in each stanza of the song text). As Figure 1.23 shows, there is a high degree of consistency in the frequency of songs with seven, eight, and ten phrases in all four manuscripts; combined, these three lengths make up seventy to seventy-five percent of all melodies in each source.

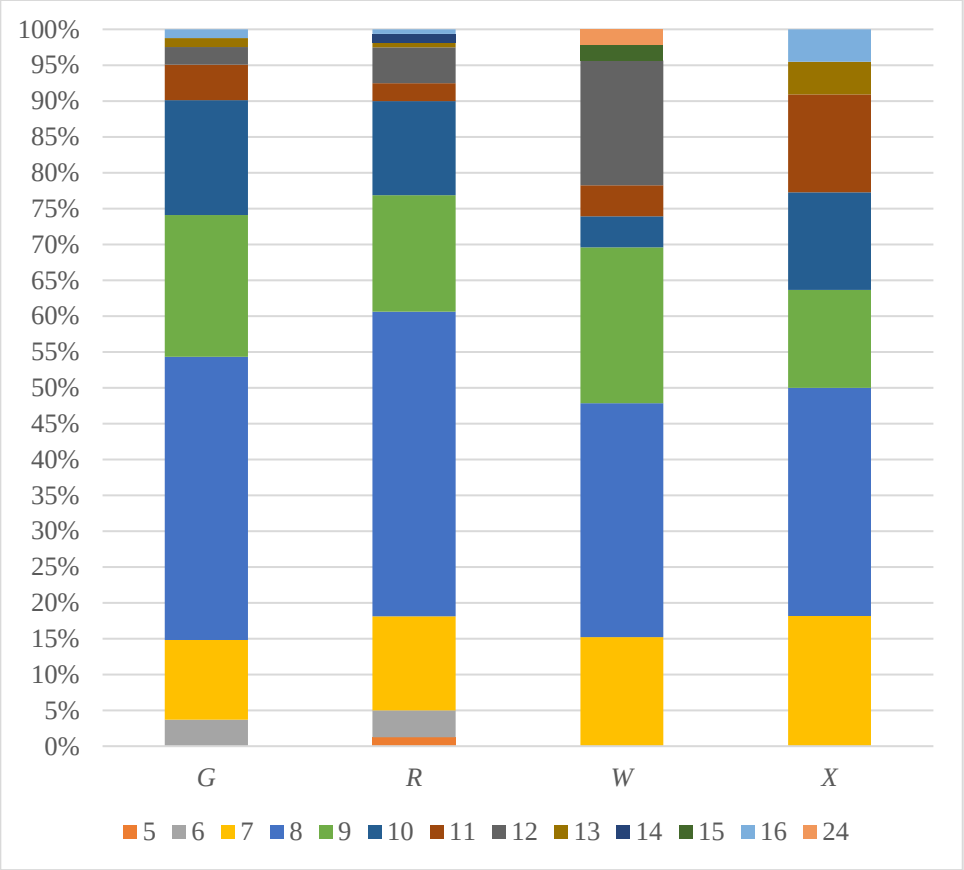


Figure 1.23: Number of phrases per melody in G, R, W and X

The sources show differences in their inclusion of melodies with more than ten phrases, however. *X* has the largest percentage of melodies with eleven, thirteen, or sixteen phrases of the four manuscripts; it also lacks melodies with twelve phrases, which are found in the other three sources (*W* has the largest percentage of twelve-phrase melodies). *G* and *R* have the most similar distribution of melodies by phrase length among the main manuscripts, with *R* also including a small percentage of melodies with five or fourteen phrases.

Based on the musical features considered (the boundary notes, ranges, PPN, and length), the four main manuscripts typically have more similarities than they do differences, with *W/X*

having more in common for some of these parameters than they do with *G/R*. For several of these features, *X* stands out from the other three sources, showing a different usage of ranges, lowest pitches, and first pitches (and to a slightly lesser degree, highest pitches). The earliest of the sources thus shows the most consistent differences from the other manuscripts, with evidence of higher degrees of similarity between the two trouvère sources and the two Occitan chansonniers (who are also closer to each other chronologically than to *W* or *X*).

Chapter II

Application I: Text Analysis Tools

In this chapter, I utilize methods drawn from text analysis to describe and study selected features of the troubadour melodies through a combination of distant and close reading. The methods applied here are the representation and analysis of concordances, collocations, and similarity, which can be accomplished by using corpus analysis software, such as AntConc, and Latent Semantic Analysis (LSA), as described in Chapter I. While these methods and tools were developed to find patterns within and relationships between large textual corpora (a process also known as text mining), they can be applied to the encoded troubadour melodies because the chosen encoding method (Volpiano) utilizes alphanumeric strings. One major difference is that, while text is separated by spaces, which demarcate words, the melodies are divided into neumes separated by hyphens which separate pitches from different syllables, words, and neumes. A melodic phrase encoded in Volpiano as "d-c-def-e" is thus read as four separate neumes, three with one pitch and one with three (d', c', d'e'f', and e'). Text analysis tools can thus process the melodies to facilitate comparisons of the melodies both with respect to the overall sequence of notes as well as their arrangement of pitches within neumes. This capability makes the tools particularly useful when studying both features and variations of melodic style.

My goal here is to identify patterns through distant reading which can then be examined in detail through more traditional analysis through evaluation of melodic content, contour, and other features. Utilization of these methods can proceed either from direct observation of the data itself to discern trends or from comparison of the results of analysis to previous scholarship to refine current perspectives. The case studies here adopt a mixed approach, seeking to document

the possibilities of these analytical methods while also contributing to existing discussions about particular musical features of the melodies. The first case study details the extent and musical characteristics of Guiraut Riquier's melismatic writing, including a catalog of all melismas in his works. The second case study shifts techniques to evaluate the similarity of melodic concordances using an LSA tool which evaluates document similarity to assess the stability of transmission for songs with melodies in multiple sources and the similarity of the melodies notated for the first and second stanzas in *G*.

Case Study 1: Melismas in the Melodies of Guiraut Riquier

Tools from the field of corpus linguistics are applied here to the extant melodies of Guiraut Riquier, a troubadour born in Narbonne active from c. 1254-1292. Riquier travelled to many of the prominent courts of the period, including that of Jaime I, King of Aragon, at Montpellier, that of Alfonso X, King of Castile, in Toledo, and several courts in Occitania.[151] Riquier has a significant position among the troubadours for several reasons. First, he is considered to be the last of the troubadours chronologically.[152] Second, he has the most extant melodies of any troubadour (forty-eight, comprising fourteen percent of the extant melodic repertory overall); further, his melodies are quite different in style from the majority of those by

[151] Aubrey, *Music of the Troubadours*, 24. With the exception of a nineteenth-century edition, Riquier's poetry has not been edited as a unit. One scholar announced her intention to publish such an edition in 1994; see Valeria Bertolucci Pizzorusso, "Un progetto di edizione del Libre di Guiraut Riquier ed alter osservazioni," *Tenso* 9, no. 2 (1994): 106–25. For a more detailed bibliography on Riquier from a variety of scholarly perspectives, see Wendy Pfeffer and Robert A. Taylor, eds., *Bibliographie de la littérature occitane: Trente années d'études (1977-2007)* (Turnhout: Brepols, 2011), 440-445.

[152] See Olivia Holmes's discussion of Riquier and his place in the troubadour repertory. Holmes, *Assembling the Lyric Self*, 103.

other troubadours.[153] Third, the circumstances of his works' transmission are unique; his melodies (all unica), appear as a coherent collection in *R* with rubrics that include dates for almost every song.[154]

Riquier is also exceptional in that he may have had a conscious role in the written transmission of his songs.[155] Evidence for his involvement appears in the only two troubadour sources which transmit his songs, both made in Occitania: *R* and *C*. Both manuscripts are from the early fourteenth century and transmit his songs in the same order. *C*, a text-only source, has the same dated rubrics found with the songs in *R*; however, in *C* the rubrics are numbered sequentially.[156] Literary scholar Olivia Holmes devotes a chapter to Riquier in her study of authorship in the thirteenth and fourteen centuries; she notes that Riquier's songs in both *R* and *C* are organized by date within larger groupings by genre, a reflection of the autobiographical nature of his book of songs.[157] Michel-André Bossy also establishes that the chronological ordering within these genre groups reflects Riquier's plan for a unified presentation of his songs.[158] This organization, appearing consistently in two sources, demonstrates careful planning

[153] Aubrey, *Music of the Troubadours*, 232. Riquier has the second-largest number of texts extant among troubadours overall (105). Olivia Holmes, *Assembling the Lyric Self*, 105. Anglés edited and published transcriptions of his melodies which is still the only complete published scholarly edition of his melodies. It is available in *Scripta Musicologica* (Rome: Edizioni di storia e letteratura, 1975-1976).
[154] The materiality of the songs and their rubrics is discussed in Aubrey's larger study of *R*. Aubrey, "A Study of the Origins," 86-89 and 346-351.
[155] In her discussion of Riquier's authorial relationship to his transmitted works, Olivia Holmes states that Riquier "clearly conceived of his work as something vaster than the individual songs. Riquier dated and numbered the poems of his *libre* in order to make them tell a story, to mimic change and motion, but also to tie them down, to give them authority and stability." Olivia Holmes, "The Representation of Time in the "Libre" of Guiraut Riquier," *Tenso* 9, no. 2 (Spring 1994): 128.
[156] A comparison of the similarities and differences between *C* and *R*, particularly with respect to the works of Riquier, can be found in Aubrey, "A Study of the Origins," 278-280.
[157] Olivia Holmes, *Assembling the Lyric Self*, 103-105.
[158] Michel-André Bossy, "Cyclical Composition in Guiraut Riquier's Book of Poems," *Speculum* 66, no. 2 (April 1991): 278-279. A list of Riquier's songs with the dates recorded in their rubrics is also provided in Bossy's article on pages 292-293.

for the presentation of these works.[159] Further, *C* includes an introduction to the songs which claims the texts were copied from a source written in Riquier's own hand:

> *Aissi comensan lo cans den: Guiraut riquier de narbona en aissi cum es de cansos. e de verses. e de pastorellas. e de retroenchas. e de descortz. e dalbas. e dautras diversas obras en aissi ad ordenadamens cum era ad ordenat en lo sieu libre. del qual libre escrig per la sua man fon aissi tot translatat. e ditz enaissi cum de sus se conten.*
>
> Here begin[s] the song[160] of Mr. Guiraut Riquier of Narbonne, made up as it is of *cansos*, *verses*, *pastorellas*, *retroenchas*, *descortz*, *albas*, and various other works, in the same order as it was ordered in his book, from which book, written by his own hand, it was all copied here, and it says the same [there] as is contained here below.[161]

These references to his role in the written transmission of his works suggest that the melodies attributed to him are closer to authorial intention (of music and text) than is generally considered possible for the repertory, which was largely written down decades (or longer) after the death of the troubadour they are ascribed to and saw varying degrees of scribal influence.[162] Riquier thus presents a unique opportunity to analyze the musical style of a troubadour who not only has a large output, but also has evidence for his involvement in its copying.

[159] Hendrik Van der Werf argues that the gaps in the copying of the melodies, as well as material aspects like spacing, support oral transmission of the songs rather than their copying from an exemplar that Riquier wrote himself. See Van Der Werf, *Extant*, 24-28.
[160] Michel-André Bossy translates this as "the singing" instead based on his interpretation of a grammatical disagreement in the original text. Michel-André Bossy, "Cyclical Composition in Guiraut Riquier's Book of Poems," 280.
[161] Holmes, *Assembling the Lyric Self*, 103.
[162] Aubrey states that the "texts and melodies in the manuscripts represent a synthesis of the input of composers, singers, and scribes." Aubrey, *Music of the Troubadours*, 34. Aubrey raises points about the copying of particular sources in her discussion of the manuscripts, 34-49. Hebbard also refers to the role of scribes and the distance between composition and transmission of troubadour songs in the extant sources, as well their role in variations in copying, in her commentary on Lachmannian perspectives on source relationships and Paul Zumthor's concept of *mouvance*. Hebbard, "Manuscripts," 31 and 38-39.

First, I provide an overview of the melismatic character of the repertory overall and of Riquier's melodies in particular, including a catalog of melismas in Riquier's melodies.[163] I then focus on melismas six notes and longer in Riquier's works to identify both the extent and the characteristics of his melismatic writing. Riquier's melodies are not only significant because of their number and his intervention in their transmission, but also because aspects of their musical style set them apart from most troubadour songs. These features include persistent use of melismas which, in some cases, are repeated within individual melodies and in multiple songs. His melismas also tend to be longer than typical for troubadour song and appear in a wider variety of positions within phrases.[164] Chantal Phan observed that the number of notated melismas in Riquier's work could reflect his deliberate inclusion of written ornaments in the notated melodies rather than allocating the task of including melismas to the performer.[165] His role in the transmission of his works could then explain the significantly higher number of melismas in his works compared to other troubadours, making the melismas more an issue of their transmission rather than their musical style during performance. However, there are multiple melodies attributed to other troubadours with a considerable number of melismas that lack evidence of authorial involvement in their copying; this suggests that control of ornamentation is not the sole explanation for Riquier's notation of melismas.

While it is possible that Riquier's melismatic writing is partially indebted to an attempt to control performers' elaborations of his melodies, it seems likely that the melismas are

[163] The catalog is located in Appendix D. It includes a list of all the melismas by length, ordered internally by pitch. The catalog includes the total number of occurrences for each melisma as well as the number of melodies each melisma is found in. A full catalog of melismas in the entire corpus, with a melisma concordance, is available in the TMD.
[164] Aubrey comments on cases in which melodic variants have differing placements of melismas in *Music of the Troubadours*, 270-272. She also states that melismas appear most often at cadences early in the troubadour period, then appear in other locations in the melodies over time. Aubrey, *Music of the Troubadours*, 235.
[165] Phan, "Structures poético-musicales," 164.

representative of his compositional style specifically. Phan traced connections between melismas in Riquier's melodies with specific aspects of text in another study, including relationships between melismas and meter and melismas and specific words (such as "*chantar*").[166] This research supports the significance of the melismas to the melodies beyond simply serving as written-out versions of elaborations typically added during performance. Further, the melismas often play a role in the motivic structure of his melodies; as Aubrey notes, the majority of Riquier's melodies include one or more motives that occur multiple times within a melody.[167] She demonstrated this using the melody for "Be·m meraveill co non es envejos" (BEdT 248,018), which she analyzed by dividing it into four motives (one of which includes two melismas) that appear with variations or in different orders in the melody.[168] Riquier's other melodies also have melismas that function as integral components of their motivic structures, rather than serving as ornaments found primarily near cadences.

Based on their structural role in the melodies, I agree with Phan that the melismas are a deliberate feature of Riquier's style rather than simply a way of ensuring performers sang an authorially-dictated version of the melody. Taking this position as a starting point, I analyzed the melodies in order to determine the exact characteristics of his melismas in terms of length, contour, and position. This case study thus builds on Phan's assertion of authorial control of the melismas within the larger motivic structures of Riquier's melodies by specifying the musical features of the melismas themselves. For this analysis, I used AntConc, an open-source corpus analysis tool, to create a list of individual pitches and pitch groups that appear in the melodies. AntConc creates concordances of the motives which can be viewed as collations or compared by

[166] Phan, "Le style poético-musical de Guiraut Riquier," 67 and 71.
[167] Aubrey, *Music of the Troubadours*, 192.
[168] Aubrey, *Music of the Troubadours*, 193.

their position within the melodies using distribution plots.[169] For this analysis, accidentals were ignored in processing because they are encoded as two characters in Volpiano; this would have thus caused melismas with accidentals to appear longer than they actually are.[170] As described previously, the software reads pitches as individual notes or groups based on their text underlay and neume structure, so that each item in the list represents one neume (which, in nearly all cases, contains all of the pitches sung to one syllable). An excerpt from such a list in AntConc appears in Figure 2.1 below (the pitches appear as Volpiano alphanumeric strings in all screenshots from AntConc).

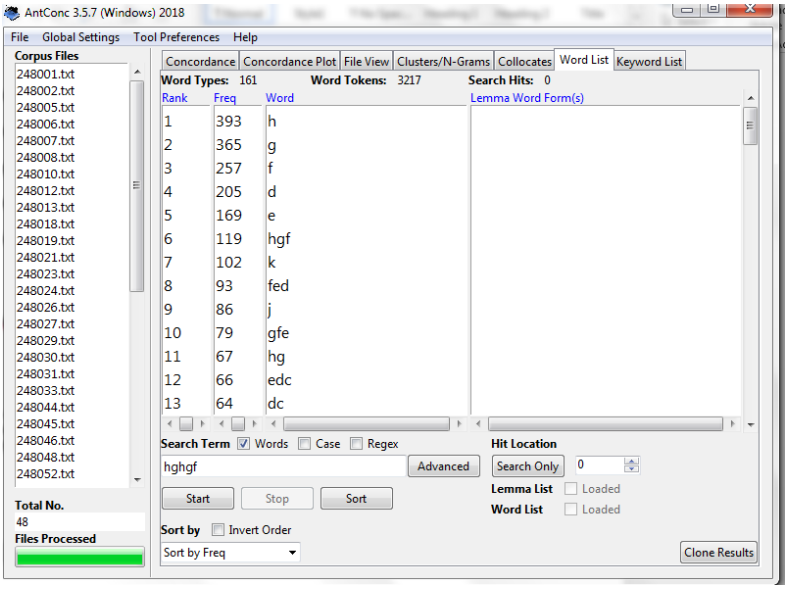


Figure 2.1: Pitches and pitch groups in AntConc (excerpt)

From this list of melodic components, I visualized the melismas and their occurrences within each melody using distribution plots, which (as described in Chapter I) represent the

[169] This type of visualization is discussed in Chapter I.
[170] For example, a B-flat in the treble staff would be encoded as ij and would thus be counted automatically as two pitches instead of one when the lengths of melismas were automatically counted by number of characters.

occurrence(s) of a melisma within a standardized representation of each melody's length. For the purpose of this analysis, I define melismas as four or more pitches written as one neume over one syllable.[171] Based on the frequency of occurrence and the length of the melismas, I calculated the percentage of the corpus that each melisma length accounts for in the entire repertory; for Riquier in particular; and for the repertory without Riquier. These comparisons are then used to contextualize Riquier's melismas within the larger extant repertory.

The troubadour melodies are notated with neumes which represent one to eleven pitches.[172] The frequency of melismas decreases sharply as their length increases, visualized in Figure 2.2 below, which compares the total number of neumes at least three pitches long for the repertory overall; for the repertory without Riquier; and for Riquier's melodies alone (see Figure 2.2 below).

[171] Here my method agrees with that of Chantal Phan, who designated neumes with two or three pitches as neumatic, with longer neumes designated melismatic in her analysis of Riquier. Phan, "Le style poético-musical de Guiraut Riquier," 164. This distinction is also that applied by Aubrey in her study; she refers to four-note melismas in her monograph. Aubrey, *Music of the Troubadours*, 203. Melismas are generally considered to have at least five notes in musicological discussion of text setting styles from this period, while neumatic applies to settings with two to four notes per syllable.

[172] The counts and percentages used in this chapter are based on the 342 melodies encoded in the TMD. Melismas are compared here at pitch level, not in transposition.

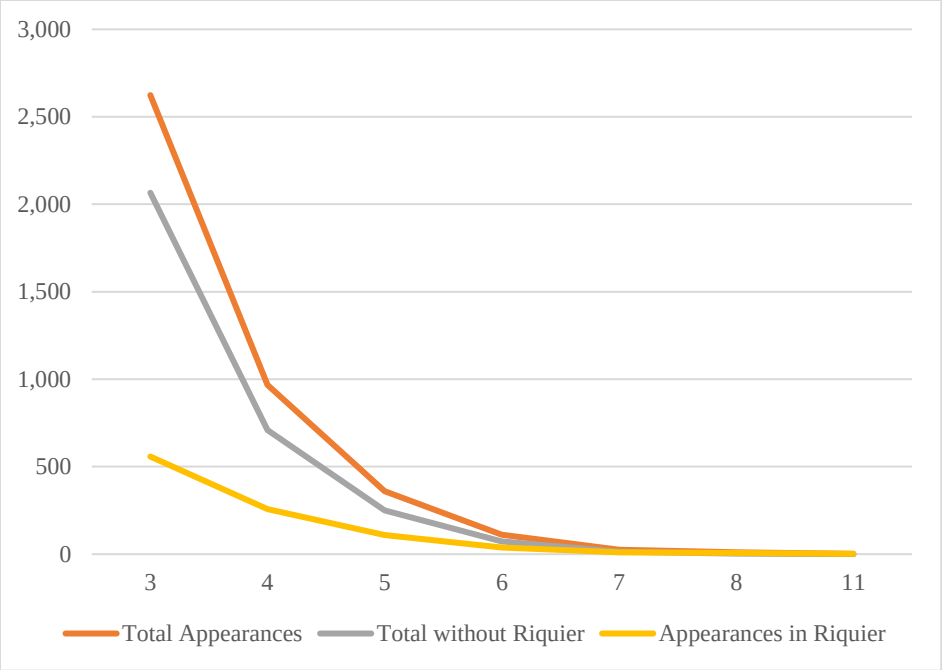


Figure 2.2: Comparison of melisma occurrences by length

Riquier's melismas also decrease in frequency as they lengthen, but less steeply than the repertory overall, as seen in the more gradual descent of the line representing Riquier's melisma occurrences compared to the rest of the melodies in the figure above. Some melisma lengths appear at a higher rate in his melodies than in the entire remainder of the repertory; for example, as seen in the detail in Figure 2.3 below, Riquier has more instances of eight-note melismas than the entire remainder of the repertory (Riquier has seven, the remaining melodies have four).

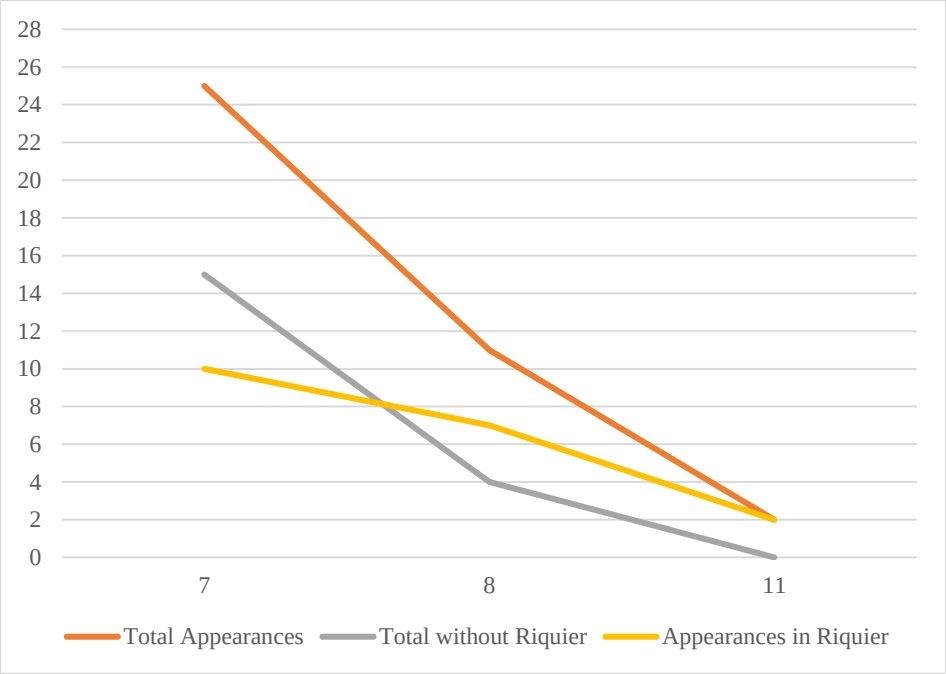


Figure 2.3: Detail showing appearances of neumes from seven to eleven pitches

From this starting point, I determined the specific characteristics of Riquier's melismas. My approach included tracking the internal repetition of melismas as well as their occurrence in multiple melodies. Twenty-five melismas at least six pitches long appear in Riquier's output; eleven of these appear at least twice in his works, and five of those eleven appear in multiple melodies. The five recurring melismas are all conjunct; all span a third to a fifth; and all primarily use the notes f'g'a'b'.[173] Those five recurring melismas will be the focus of the discussion here (marked in bold in Figure 2.4).

[173] Only two of the twenty-five melismas at least six pitches long in Riquier's works contain a leap. Of the five recurring melismas here, only f'g'a'b'a'g' appears in a melody not attributed to Riquier (Aimeric de Pegulhan's "En amor truep alques" (BEdT 10,025) in both its versions).

Motive Length	Motive	No. of Melodies	Occurrences
6	**f'g'a'b'a'g'**	3	5
	g'f'f'e'd'c'	2	2
	g'a'b'a'g'a'	6	7
	a'g'a'b'a'g'	7	10
	b'a'b'a'g'a'	1	2
	c''b'b'a'g'a'	1	3
	e''f''g''f''e''d''	1	2
7	f'g'a'b'a'g'a'	1	5
8	**g'f'g'a'b'a'g'a'**	2	3
	a'b'a'g'g'f'e'f'	1	2
11	a'b'a'g'a'g'f'e'd'c'd'	1	2

Figure 2.4: Melismas with 6 to 11 pitches in Riquier's melodies

The melisma that appears most often in Riquier's melodies is a'g'a'j'a'g'. It appears in seven melodies ten times (once in four melodies and twice in three); seven occurrences are in the first half of a melody. Six of those instances are a result of the songs' forms, in which the first melodic phrase is the same as the third. The positions of these melisma occurrences are represented in Figure 2.5 below, which contains distribution plots for these seven melodies with all occurrences of a'g'a'j'a'g' marked by bars within the overall structure.[174]

[174] For further discussion of this type of visualization, see Chapter I.

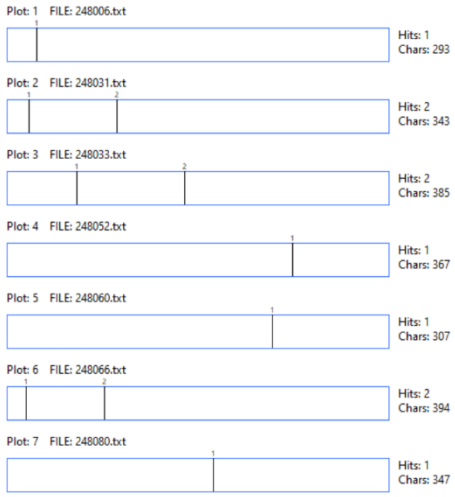


Figure 2.5: a'g'a'j'a'g' in melodies by Riquier

The varied placement of this melisma points to Riquier's use of melismas throughout his compositions, rather than consistently having them concentrated later in the melody or placed primarily at cadences.[175] To further specify the positions of his melismas, and to compare those within the context of melisma positions in the repertory overall, I compiled a list of melisma positions for each melody. This includes the number of melismas at final and internal cadences, melismas which appear as penultimate gestures at final and internal cadences, and those which appear elsewhere in the melody.

There are two broad types of internal melisma repetition: those caused by repetition within the form of a melody, so that a phrase with a melisma appears multiple times, and those which appear in different positions within a melody. Troubadour melodies typically have forms

[175] Distribution plots showing the position and number of all melismas in Riquier's melodies are available in the TMD.

which repeat one or more phrases within their structure rather than being through-composed.[176] There are exceptions to these typical forms, including ones which are through-composed, contain refrains, or have versicle structures like the *lais*. Repeated phrases may have some degree of variation from previous instances, such as those necessary to adapt to the new line of text. Aubrey refers to this type of alteration as intrinsic variations: "many melodies contain one or more repeated phrases or motives internally, which often manifest some variants that I will call intrinsic."[177] Outside of this type of formal repetition, the position of melismas within the structure of the melody and its phrases can be significant; Aubrey notes in her study that melismas within troubadour song are found most often at cadences then, over time, appear at a wider variety of locations.[178] The extent to which Riquier's melismas reflect this is also considered here within the broader context of typical melisma positions in the repertory.

In addition to his tendency to use longer melismas than typical in his notated melodies, Riquier also used several melismas more than once in the same melody. For instance, two of his six-note melismas appear in at least six different melodies (listed above in Figure 2.4).[179] "Jhesus Cristz, fills de Deu viu" (BEdT 248,046) demonstrates this aspect most clearly of his melodies; the extent of the melismatic writing in "Jhesus Cristz" is so marked that Phan drew heavily on this melody for her discussion of melismas and their role in Riquier's songs.[180] She divided the melody into motives to evaluate the relationship between particular motives and specific words

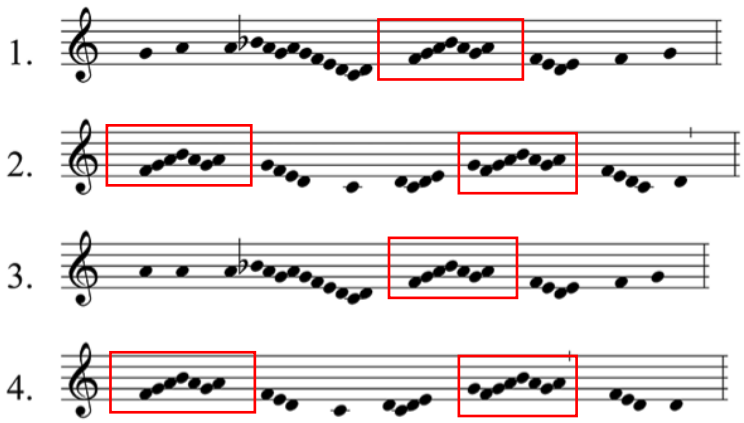
[176] For a longer discussion of form in the troubadour melodies, see Aubrey, *Music of the Troubadours*, 132-194 (particularly 146-173), Van der Werf, *Extant*, 66-72, Steel, "Influences on Musical Style," 29-32, and Vanin, "Musical form and tonal structure," Chapters 2 and 3.
[177] Aubrey, *Music of the Troubadours*, 50.
[178] Aubrey, *Music of the Troubadours*, 235.
[179] The most frequent, a'g'a'j'a'g', has ten occurrences. The melisma g'a'j'a'g'a' has seven, and f'g'a'j'a'g' has five. These three melismas thus have twenty-two combined occurrences in Riquier's works, while the other nine have twenty-one. One seven-note melisma also appears five times (f'g'a'b'a'g'a').
[180] Phan, "Le style poético-musical de Guiraut Riquier," 165-169.

or aspects of the poetic structure.[181] She identified one multi-syllable motive which contains an eleven-note melisma (seen in Music Example 2.3); she describes this melisma as "*le grand mélisme principal*" that appears in different variations.[182] The melisma in "Jhesus Cristz" with the most appearances is the seven-note melisma f'g'a'j'a'g'a', which Phan designates as motive a2/a3/a4/a10 in her analysis depending on its position.[183] This seven-note melisma appears five times in the song:

Figure 2.6: Distribution plot of f'g'a'j'a'g'a' in "Jhesus Cristz"

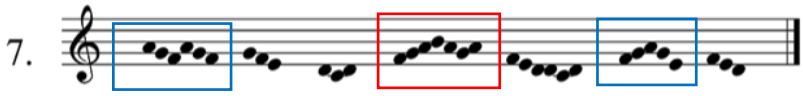
Here, the melisma appears so frequently because Riquier used it in the first two phrases, which repeat as the third and fourth phrases (marked in red in Music Example 2.1 below). An almost identical eight-note melisma appears in the first and third phrases (also marked in red):

[181] Phan breaks the melody down into three motives for the first four phrases, four motives for phrases five and six, and two motives preceded by three unclassified neumes in the final phrase. Her list of motives and a transcription of the melody with those phrases marked can be found in Phan, "Le style poético-musical de Guiraut Riquier," 168-169.
[182] Phan, "Le style poético-musical de Guiraut Riquier," 166.
[183] Phan, "Le style poético-musical de Guiraut Riquier," 168-169.



Music Example 2.1: Phrases 1-4 of "Jhesus Cristz"

Phrase 1 and 3 also contain the eleven-note melisma which is the longest found in the entire troubadour repertory (discussed in further detail below). The seven-pitch melisma appears a fifth time in the final phrase (marked in red), as do two of the four melismas with five or more notes containing a leap in Riquier's repertory (marked in blue).[184]

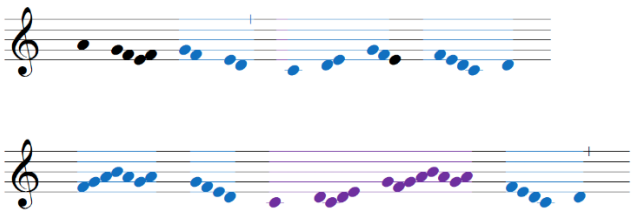


Music Example 2.2: Final phrase of "Jhesus Crist"

"Jhesus Cristz" is thus exceptional in the length of its melismas and its use of melismas at least five pitches long with an internal leap in Riquier's melodies.

[184] There are three four-note melismas with intervals larger than a second in works by Riquier, two five-note, one six-note, and one seven-note melismas with leaps. There are four, five, and six-note melismas with an internal leap appear in melodies by other troubadours.

With the melismas in his works catalogued by length and features, I applied another type of analysis to Riquier's melodies to discover if these melismas appear together in his works in a larger-scale melisma pair or group. To accomplish this, I used a type of search that finds collocates (an analysis which finds words, or here, melismas, within a set distance of each other).[185] I focused on the same five recurring melismas discussed above; while there are cases when the melismas do appear near each other, there are also cases where melismas are similar rather than identical. These differences are usually caused by alterations to text setting or the addition or removal of a pitch. One of the clearest cases of Riquier's reuse of melismas between melodies is that found in "Humils, forfagz, repres e penedens" (BEdT 248,044, dated to 1273 in its rubric) and "Jhesus Cristz" (BEdT 248,046, dated to 1275 in its rubric). Riquier included the eight-note melisma g'f'g'a'b'a'g'a' (one of the five recurring melismas discussed previously) in both melodies, combining it with shorter motives to create a longer related phrase. In Music Example 2.3 below, the eight-note melisma is marked below in purple, while shorter motives or related melismas are marked in blue.

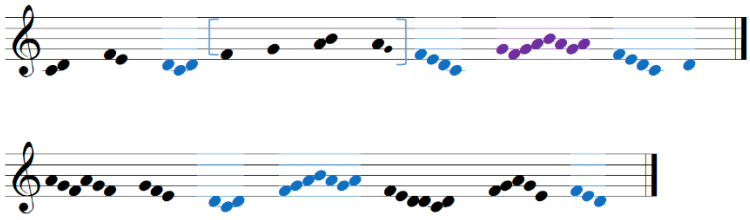


Music Example 2.3: Phrase 2 of "Humils, forfagz" (top) and "Jhesus Cristz" (bottom)

Brackets surround the pitches in the final phrase of "Humils, forfagz" (BEdT 248,044) that correspond to six of seven pitches in a melisma from the final phrase of "Jhesus Cristz" (see

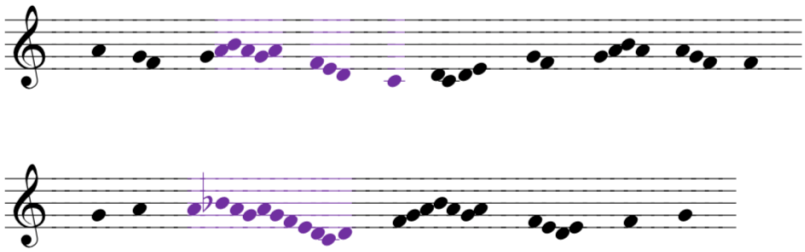
[185] AntConc supports this type of corpus analysis so it was used in this part of the study as well. For a discussion of collocates, see the section of Chapter I on textual analysis methods used in this project.

Music Example 2.4). The eight-note melisma is marked in purple and related pitches in blue as in the previous example.



Music Example 2.4: Final phrase of "Humils, forfagz" (top) and "Jhesus Cristz" (bottom)

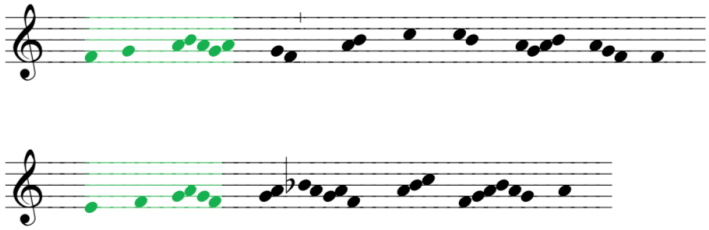
The shared melismas thus create a musical connection between the second and final phrases of both melodies, as well as between the melodies themselves. The first phrase of both melodies lacks an identical melodic connection, but do have a similarity. The eleven-note melisma discussed above appears in the first phrase of "Jhesus Cristz" as the third neume, while the third through fifth neumes of "Humils, forfagz" match eight pitches of that melisma (marked in purple in Music Example 2.5):



Music Example 2.5: First phrase of "Humils, forfagz" (top) and "Jhesus Cristz" (bottom)

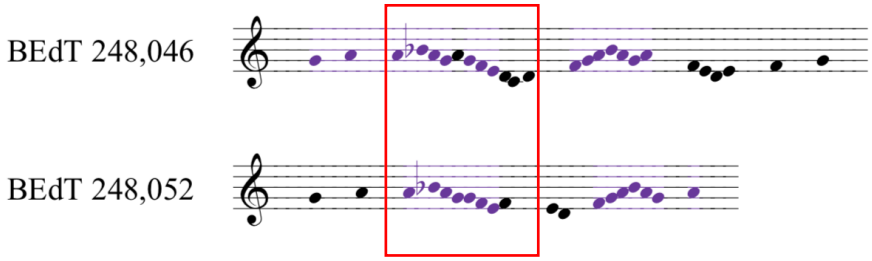
This repetition of melismas is part of a longer related phrase which reflects Riquier's use of repeated material within individual melodies, creating exact or varied links between phrases. One

additional connection between the melodies is that the fifth phrase of both songs opens with a nearly identical three-neume motive a step apart (marked in green in Music Example 2.6 below):



Music Example 2.6: Fifth phrase of "Humils, forfagz" (top) and "Jhesus Cristz" (bottom)

The shared and similar melismas in these two melodies point to Riquier's use of melismas across melodies that he composed, based on the dates in the *R* rubrics, two years apart. The eleven-note melisma in Music Example 2.5 also creates a connection between these two songs and "Lo mons par enchantatz" (BEdT 248,052), written nearly ten years later in 1284 according to its rubric (corresponding pitches are marked in purple in Music Example 2.7):



Music Example 2.7: First phrase of "Lo mons par enchantatz" and "Jhesus Cristz"

The two melodies open nearly identically, with the eleven-note melisma of "Jhesus Cristz" matched by a quite similar eight-note melisma in "Lo mons par enchantatz" (BEdT 248,052). The two phrases also share a seven-note melisma in "Jhesus Cristz" that appears as a six-note melisma followed by a single pitch in "Lo mons par enchantatz" (marked in red above). These three melodies thus demonstrate melisma reuse across melodies over a ten-year period, showing

musical connections across the majority of the musical phrases in "Humils, forfagz" and "Jhesus Cristz," and a lower-level connection through one musical phrase in "Jhesus Cristz" and "Lo mons par enchantatz."

As noted previously, Riquier uses melismas at a variety of positions within phrases; this can be seen in Figure 2.7 below, which represents the phrases of "Jhesus Cristz" as numbers representing the length of the neume (melismas are marked in red) found over each syllable (seven per phrase).

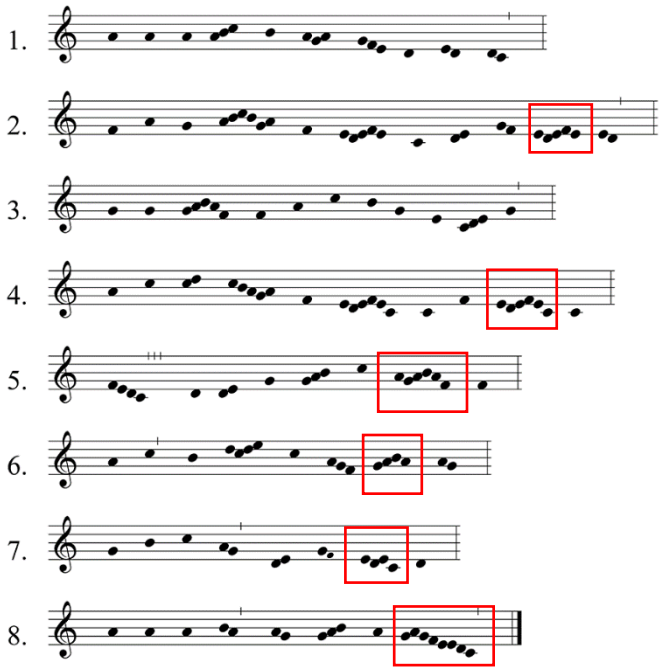
Phrase 1	1	1	11	7	4	1	1
Phrase 2	7	4	1	4	8	4	1
Phrase 3	1	1	11	7	4	1	1
Phrase 4	7	3	1	4	8	3	1
Phrase 5	1	1	4	7	3	6	1
Phrase 6	1	3	8	7	6	5	7
Phrase 7	6	3	3	7	6	5	3

Figure 2.7: Phrases as neume lengths in "Jhesus Cristz"

Melismas appear at the beginning of three phrases of this melody, and appear at least once on each of the seven syllables in the phrases. They are thus a consistent feature of the melody, including at the beginnings, middles, and ends of phrases. To better establish the positions of melismas in Riquier's melodies, I gathered data about the melismas that appear at final and internal cadences, both as cadential and penultimate gestures.[186] Melismas of four to seven pitches in length appear at both internal and final cadences in the extant melodies; there is also

[186] The data table with these tabulations is available in the TMD.

one case of a final eight-note melisma (see Music Example 2.8; melismas at or next to cadences are marked in red).[187]



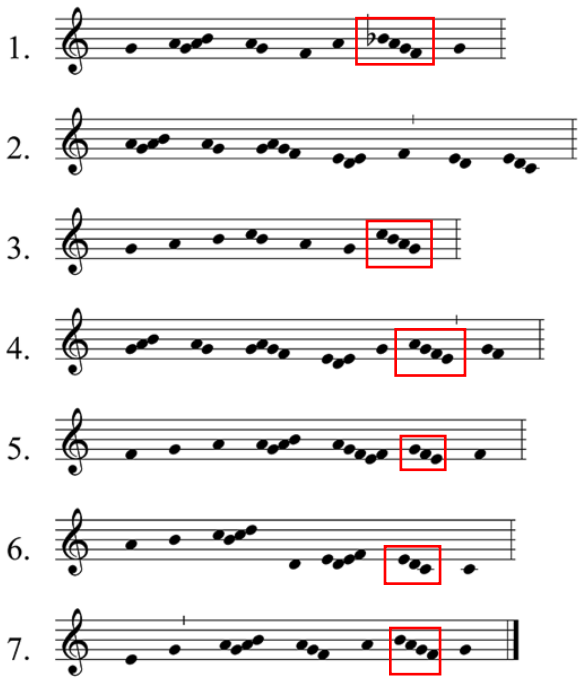
Music Example 2.8: Cadential melismas in "Trop ai estat" (BEdT 370,014)

Four- and five-note melismas appear at nearly the same rate as internal cadential melismas or internal penultimate ones. Six-note melismas appear more often as the final gesture than the second-to-last, while the opposite is true for seven-note melismas. Four-pitch melismas are found more often as penultimate gestures at final cadences than as the cadential one; however, longer melismas appear more often as the final melodic gesture instead.

Riquier's melisma placement has some differences from the corpus overall; he tends to use a single note at final cadences (about half of his melodies) and melismas or a ternaria as the

[187] This melody is the version in *G* of Perdigon's "Trop ai estat mon Bon Esper no vi" (BEdT 370,014), which appears as Music Example 2.8. The version in *X* is missing its last phrases, so it is not included here.

penultimate musical gesture (also in roughly half his melodies). This is also true of internal cadences, where ternaria and melismas make up a majority of his penultimate neumes. Music Example 2.9 below demonstrates this in Riquier's "Ab lo temps agradiu" (BEdT 248,001), which has melismas or ternaria in the penultimate position at four internal cadences and the final cadence; it appears as a cadential gesture in phrase two.



Music Example 2.9: Melody for "Ab lo temps agradiu" (BEdT 248,001)

Based on the various visualizations and the tabulated information discussed above, I can state conclusively (and precisely) that Riquier consistently uses more melismas overall and in locations of the melody other than at or just prior to a cadence; these claims are not just supported by observation of general trends, but by numerical evidence. Further, I can identify trends in his melisma usage and place them in the context of the broader repertory. Compared to the repertory overall, Riquier uses melismas more often as penultimate gestures than as cadential

ones both at internal and final cadences. An exception to this is his use of four-note melismas, which appear more often as the final notes of internal phrases in his output than in the corpus overall. He also uses melismas throughout his melodies more consistently than the majority of other troubadours (although there are several troubadours who have at least one extant melody that also positions melismas at non-cadential moments).[188] His distribution of melismas can also be seen in Music Example 2.8, which has two melismas in every phrase except the third. Riquier's long melismas, the overall highly melismatic quality of his melodies, his use of melismas across multiple melodies, and the positioning of melismas within his melodies thus distinguish his works musically from those of the majority of other troubadours. His unique position in the repertory is thus marked by distinctive elements of his musical style, his chronological position as the last of the troubadours, and his role in the written preservation of his melodies. The catalog of melismas and delineation of their musical characteristics together add a higher degree of specificity to discussion of his melismatic writing, as does identifying the exact position of his melismas within his melodic structures. Further, the dated rubrics provided for his melodies allows us to identify not only his tendency to reuse melismas or notated many melismas in his songs, but also demonstrate the consistency of these features of his style over time.

[188] Examples include Cadenet's "Eu sui tan corteza gaita" (BEdT 106,014), Folquet de Marsellia's "Mout i fetz gran peccat amors" (BEdT 155,014 in *G*), and Perdigon's "Trop ai estat mon Bon Esper" (BEdT 370,014 in *G*), shown in Music Example 2.8. Distribution plots marking melisma placement for all of the melodies can be found in the TMD. Of the 424 occurrences of melismas found in Riquier's melodies, just under half appear as a cadential gesture or a penultimate gesture prior to the cadential note or notes. In the repertory overall, less than a third of the melismas are not at an internal or final cadence.

Case Study 2: Melody Variants and Transmission Stability

In this case study, I analyze melodies with concordances to determine the degree to which a song's melodic transmission is stable or unstable.[189] In this instance, I do not seek to explain the reasons for such variations in specific cases; Aubrey notes one possible explanation in her discussion of the inevitability of scribal influence on melodies in her work on troubadour song, while variants in performance are another possible cause for these differences.[190] Here, I apply Latent Semantic Analysis, or LSA, using the computer programming language Python.[191] The type of LSA used here is designed to process documents to find their similarity to each other based on the words in each document and their frequency of occurrence. The Document Similarity script creates a matrix which shows the statistical similarity between each melody and all others in the repertory (called a 'similarity matrix.')[192] It does this by creating a table of every individual note and note group in the melodies and identifies which melodies use each pitch or pitch 'chunk' and how often.

[189] Aubrey discusses variant readings in concordances and contrafacts in her *Music of the Troubadours*, 50-65, including a table listing the number of concordances and contrafacts in the corpus.
[190] Aubrey, *Music of the Troubadours*, 65. "The nature of the intervention of the scribes must underlie any inquiry into the compositional process and the performance practice of the troubadours' songs, since no melody that survives escapes it."
[191] The LSA script used for this project was developed by David Kloster and Tassie Gniady of the Cyberinfrastructure for Digital Humanities and Creative Activities division at Indiana University, part of Research Technologies (https://rt.iu.edu/), with support from Guangchen Ruan and Esen Tuna, also of RT. The script is located in the GitHub repository maintained by CyberDH (https://github.com/cyberdh/Text-Analysis/tree/master/TopicModeling/LSA), accessed on 15 September 2019. The script is run through a Jupyter Notebook created by the group. More information on Jupyter Notebooks may be found here: https://jupyter.org/; information on Python is available here: https://www.python.org/. This analysis was processed in Research Desktop (RED), an interface for IU's Carbonate supercomputing system. The author acknowledges the Indiana University Pervasive Technology Institute for providing HPC (Carbonate) resources that have contributed to the research results reported within this project. This research was supported in part by Lilly Endowment, Inc., through its support for the Indiana University Pervasive Technology Institute.
[192] The similarity overall is represented as cosine similarity scores. The similarity matrix for concordances is available in the TMD.

The script then determines how similar one melody is to another based on the frequency of each pitch or group of pitches in a melody (order of appearance is not taken into consideration).[193] Similarity is represented as a single numerical value (the similarity index) which ranks documents from most to least similar, with a value of 1 showing that two documents are identical. The results are displayed as a table (the similarity matrix) that lists each melody with its scores compared to every other melody in the corpus. An image of the matrix for the entire repertory appears in Figure 2.8; each row and column represent one melody's similarity to all others, with one similarity score per table cell (a detailed excerpt of the matrix appears in Figure 2.9 below). The color scale in the matrix shows how similar (green) or dissimilar (red) each melody is to all other melodies in each row. The diagonal green line visible in Figure 2.8 below shows where each melody is compared to itself at the intersection of its row and column with an identical score of one.

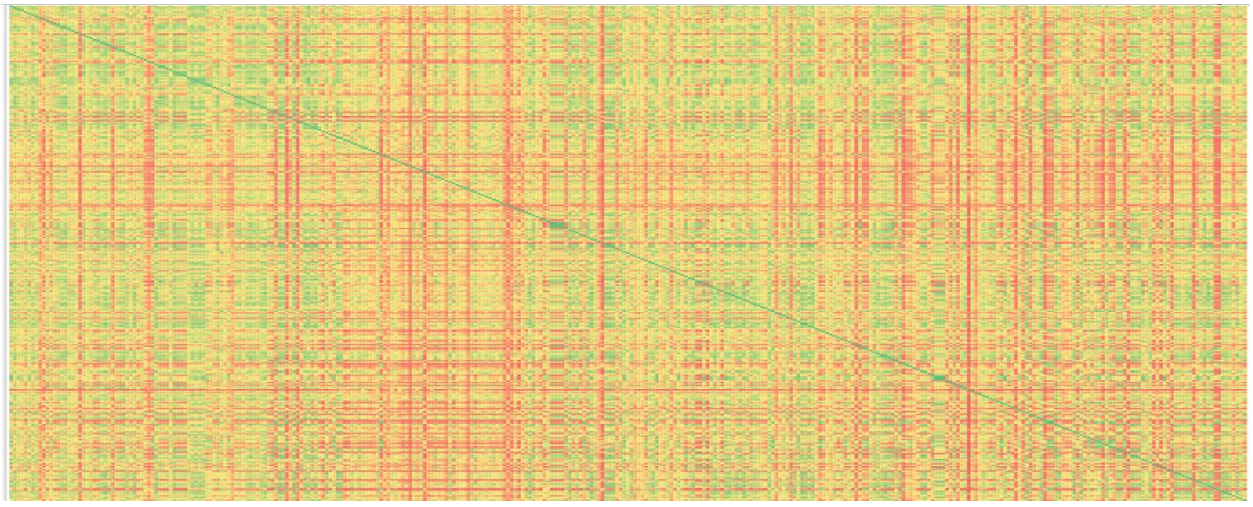


Figure 2.8: LSA similarity matrix for all encoded melodies

[193] The analysis here thus only compares the melodies at pitch level, not in transposition. Also, order is not factored into this analysis, so the melodies are compared based on the similarity of their individual components overall.

The matrix serves as a distant reading of the melodies within which points of high similarity or high dissimilarity indicate melodies that should be compared more closely to determine the nature of their relationship.

The goal for this case study is to first, establish and quantify how similar melodies with concordances in different manuscripts are to each other to identify which melodies have a very stable transmission, which are unstable, and to observe any trends in similarity visible in the matrix, and second, to describe the similarity (or differences) of musical phrases notated for multiple stanzas. For context, fifty-four songs in the repertory have melodies extant in two or more versions; 131 melodies total are extant for those fifty-four songs.[194] First, to demonstrate the validity of LSA for analysis of the troubadour melodies, I will discuss two works whose transmission is known to be stable, Matfre Ermengau's "Dregz de natura" (BEdT 297,004), or nearly stable, Richard I of England's ("the Lionheart") "Ia nuls hons pris ne dira" (BEdT 420,002). Then, I will compare the stability of transmission for melodies based on observations from the similarity matrix at the level of both individual songs and the major sources overall.[195]

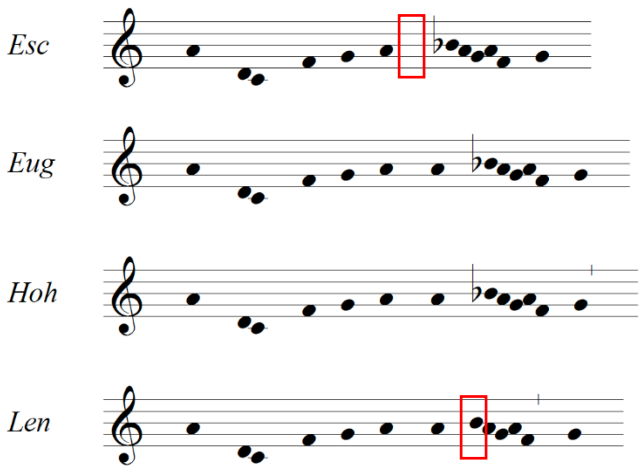
The most stably transmitted song in the entire corpus is Matfre's "Dregz de natura," which appears in nearly-identical versions in four different sources.[196] This is likely a result of the fact that they appear in copies of manuscripts transmitting Matfre's *Breviari d'amor*, and are thus part of the copying of a larger unified work. The similarity of these songs also points to the

[194] Twelve of these 113 melodies appear in minor manuscripts: one each in *Esc*, *Eta*, *Eug*, *Hoh*, *Len*, *TrouvK*, *TrouvN*, *TrouvX*, and two each in *Delta* and *Cangé*. Interestingly, the songs with the highest similarity scores in the repertory (0.99 and above) are all found in trouvère sources or copies of the *Breviari d'amor*.

[195] The source-level comparison focuses on the major sources (*G*, *R*, *W*, and *X*) because the minor sources have too few songs to draw conclusions about manuscript-level features; further, a majority of the songs in the minor sources are unica so do not have concordances available for comparison.

[196] Only two other songs are transmitted with four melodies: "Ia nuls on pris" (BEdT 420,002), discussed below, and Gaucelm Faidit's "Fortz cauza es que tot lo major dan" (BEdT 167,022), used as an example in Chapter I. "Dregz de natura" is the only one of the three songs that has a similarity index over 0.9 for all versions of its melodies. Also see discussion of this song's transmission in Hebbard, "Manuscripts," 173.

secure transmission of these melodies as part of the literate transmission of Matfre's *Breviari d'amor* in manuscripts made in both Occitania and Catalonia in the first half of the fourteenth century. The melodies have only minor internal differences, such as the lack of a flat sign in the first phrase of the version in *Len* and one fewer occurrence of a' in the first phrase in *Esc* (see Music Example 2.10).



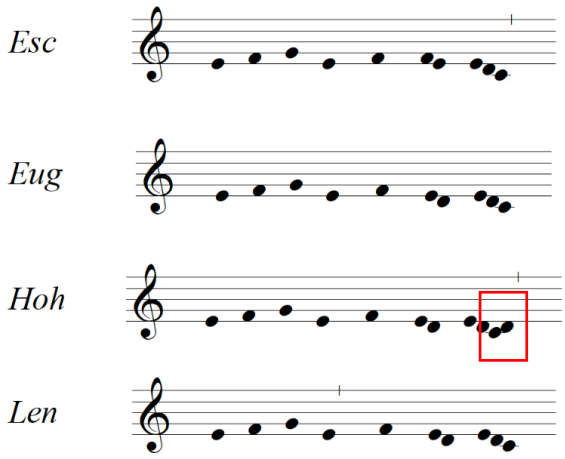
Music Example 2.10: First phrase of "Dregz de natura"

The similarity scores for these four versions of the melody appear below in Figure 2.9, showing the calculated similarity between each version:

	297004Esc	**297004Eug**	**297004Hoh**	**297004Len**
297004Esc	n/a	0.991	0.936	0.989
297004Eug	0.991	n/a	0.934	0.987
297004Hoh	0.936	0.934	n/a	0.928
297004Len	0.989	0.987	0.928	n/a

Figure 2.9: Statistical similarity of "Dregz de natura"

All of the versions have similarity scores of 0.94 or higher to the other concordances. The version with the lowest score, *Hoh*, has three individual differences from the other melodies, while *Esc* and *Len* both have two (the version in *Eug* does not have any features that differ from the other three) (see Music Example 2.11).

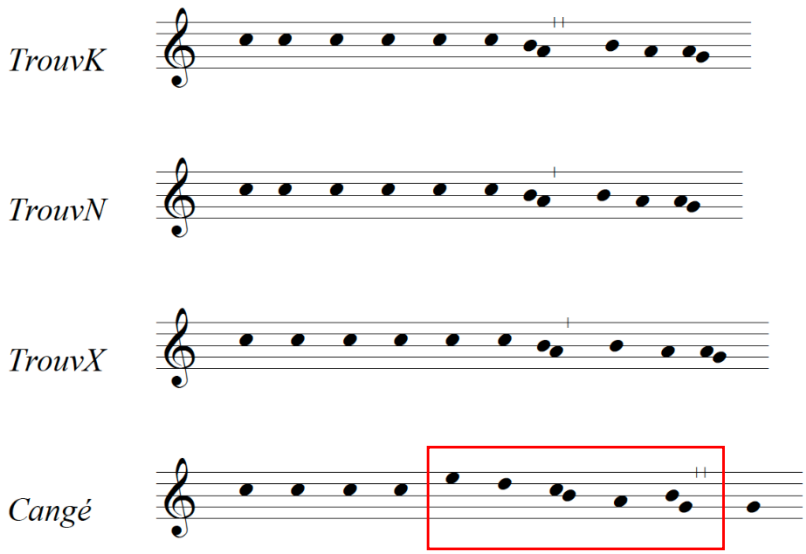


Music Example 2.11: Phrase six of "Dregz de natura"

Hoh has an additional d' at the end of the third, sixth, and seventh phrases, so that it ends on d' while the others end on c'. The form of this melody is the same in all sources (ABCCABCCCBC); the added d' in *Hoh* appears in two phrases, B and C, but not in all of their instances.

My second example is a song with more mobility between concordances: Richard I of England's ("the Lionheart") "Ia nuls hons pris ne dira" (BEdT 420,002). This song is Richard I's sole work to survive with music notation. It is transmitted in four sources with melodies, all of which are trouvère manuscripts. The three versions of this melody in *TrouvK, TrouvN,* and *TrouvX* are very similar in their transmission, while the version preserved in *Cangé* has several

differences from the other three.[197] The three versions in *TrouvK*, *TrouvN*, and *TrouvX* have only one different pitch at any point (in phrase four of *TrouvN*). The version found in *Cangé*, however, has major differences. It begins in the same manner as the other three versions, on a repeated c'; after the initial four notes, it varies for the rest of the phrase (marked in red) until the final pitch, which is g' in all versions (see Music Example 2.12).



Music Example 2.12: First phrase of "Ia nuls on pris"

The similarity scores for the four concordances from the matrix reflect this: the versions in *TrouvK* and *TrouvN* are scored as completely identical; *TrouvN* is very slightly different from those two versions; and *Cangé* has many differences from the other three (see Figure 2.10).

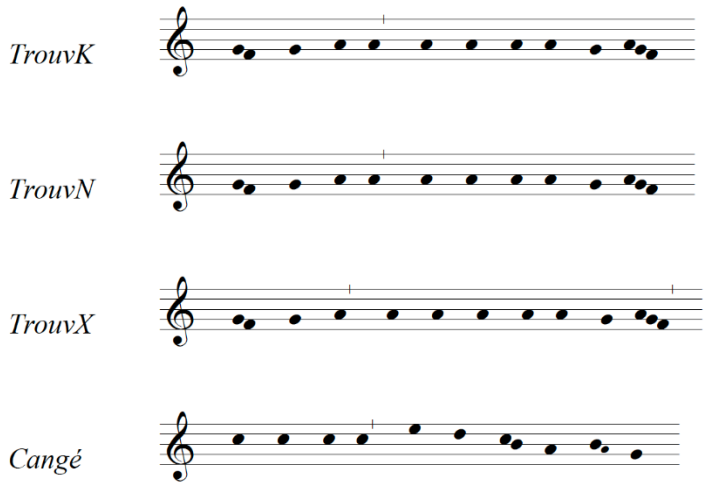
[197] Mary O'Neil discusses relationships between concordances in trouvère sources, including the *KNPX* group, in Mary O'Neil, *Courtly Love Songs of Medieval France: Transmission and Style in the Trouvère Repertoire* (Oxford: Oxford University Press, 2006), 64-66.

	420,002Cange	420,002TrouvK	420,002TrouvN	420,002TrouvX
420,002Cange	n/a	0.748	0.741	0.748
420,002TrouvK	0.748	n/a	0.994	1
420,002TrouvN	0.741	0.994	n/a	0.994
420,002TrouvX	0.748	1	0.994	n/a

Figure 2.10: Statistical similarity of "Ia nuls on pris"

The melodies for "Ia nuls on pris" in *TrouvK* and *TrouvN* are the only melodies in the entire preserved repertory that are completely identical in pitch and text-underlay.[198] There is also a difference in the form of the melody in *Cangé* compared to the other sources. Its third phrase is a repetition of the first (ABABCD); however, it is a new phrase in the other concordances (ABCDEF, with DE as variations of BC). In the comparison below (see Music Example 2.13), the third musical phrase is identical in the first three sources (*TrouvK, TrouvN,* and *TrouvX*), while *Cangé* instead presents a close repetition of the first musical phrase shown above:

[198] The next most similar melodies (with a score of at least 0.99) are the concordance of "Dregz de natura" in *Esc* and *Eug* discussed above, two of the concordances for "Ia nuls on pris" listed in Figure 2.9, and the melodies for "Gent me nais" (BEdT 461,024) in *W* and *Delta*.



Music Example 2.13: Third phrase of "Ia nuls on pris"

The fourth, fifth, and final phrases have the most differences in the version in *Cangé*, mostly due to variations in pitch level. The only differences between the other three sources musically are an oblique in *TrouvN* in the fourth phrase that does not appear in the other sources and a one-pitch difference in underlay in *TrouvK* in phrase five. Overall, the variation in pitch content and the formal difference explain the lower similarity score between these melodies compared to those for "Dregz de natura." In this case, it is likely that the versions in *TrouvK* and *TrouvN* were copied from the same source because they are not only almost identical in pitch, but also have the same layout per staff.[199] The version in *TrouvX* is very closely related to those, but may have been copied from a different exemplar or its scribe altered the spacing. The musical and layout evidence is consistent with the known origins of these sources; they are all contemporaneous but *TrouvX* was made in a different workshop than *TrouvK* and *TrouvN*. The gap in similarity between *TrouvK*, *TrouvN*, and *TrouvX* and *Cangé* demonstrates changes between the melody

[199] The only exception to this is one pitch is phrase four, where the column breaks one pitch later in *TrouvK*.

known during the copying of these three sources in the 1270s in Artois and Arras and the copying of *Cangé* in the 1280s (possibly) in Dijon.

Stability of Transmission of Concordances

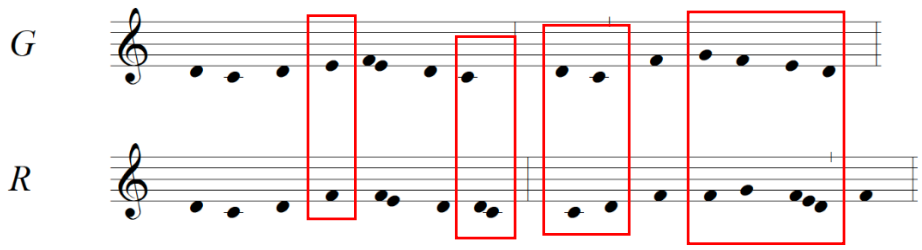
After confirming the tool's accuracy in analyzing the repertory, I used the similarity matrix to locate concordances with different degrees of stability in their transmission. This comparison by necessity focused on the major sources for troubadour melodies (*G, R, W* and *X*) as few of the minor sources have concordances. The main music manuscripts span a period of about one hundred years and come from Occitania, Northern France, and the Italian peninsula.

Sigla	Date	Origin	No. of Melodies
G	c.1270-1300	Veneto	81
R	c.1300	Occitania	161
W	c.1260s-12702	France (North)	55
X	c.1240-1250	France (North)	23

Figure 2.11: Date, origins, and size of main musical sources

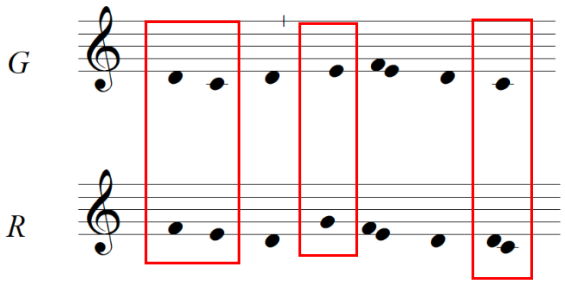
I first identified songs with a high degree of similarity in the matrix, then searched for concordances with a more mobile transmission. The song with the highest similarity scores for its concordances (after those discussed above with the highest similarity index scores) is Peirol's "Coras qem fezes doler" (BEdT 366,009); it appears in two sources, *R* and *G*. The two versions have a similarity score of 0.933 (slightly less than the lowest score for Maftre's "Dregz de natura"). The melodies for this song have very similar contours (the overall shape of the melody

through ascent and descent) and pitch content in each phrase, with a few differences in either pitch level or the number of pitches per syllable. The first two phrases demonstrate typical differences between the two versions (see Music Example 2.14); the fourth and last pitches of the first phrase are a step apart and *R* has an additional note. The second phrase has more differences in pitches and neumatic structure but is still similar. The first two notes of the second phrase are inverted between the versions, as are the fourth and fifth; *R* has three notes instead of one for the penultimate syllable of the second phrase, and ends on f' instead of d'.



Music Example 2.14: First two phrases of "Coras qem fezes doler"

The greatest degree of difference in this pair of melodies comes in the third phrase, which is a varied repetition of the first. The melody in *G* has identical first and third phrases, while *R*'s begins a third higher for the first two notes, is a second higher for the fourth, and has a reiterated d' before the final pitch of the phrase (see Music Example 2.15).



Music Example 2.15: Third phrases of "Coras qem fezes doler"

Both versions end on the same pitch in this phrase (and except for the repetition of d', end with the same four pitches over the last three syllables). These two melodies thus have more differences than those seen in the discussion of Matfre's melodies, but are still similar, as predicted by the lower (but still high) statistical similarity.

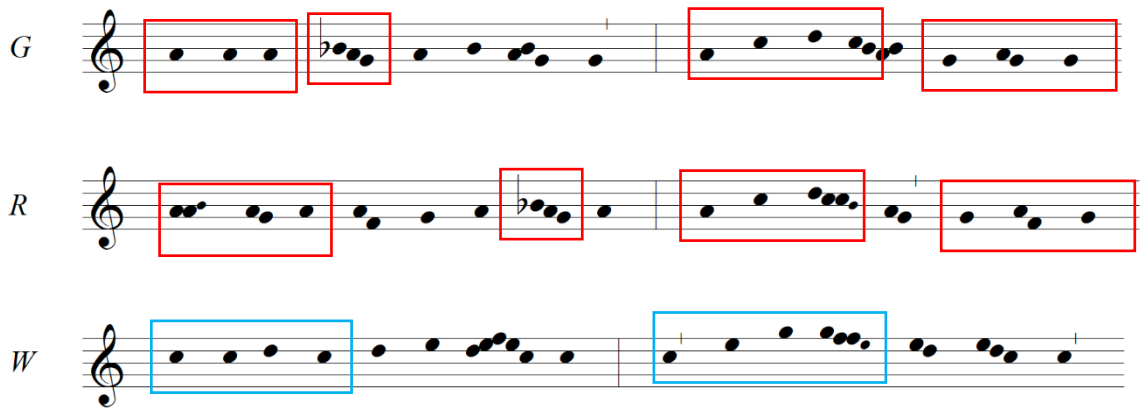
For the next step of the analysis, I identified a song with melodies extant in three quite different versions: Folquet de Marseilla's "Greu feira nuls hom faillensa" (BEdT 155,010). This song presents a case of unstable melodic transmission across three of the principal musical sources for troubadour song: *R*, *G*, and *W*, each from a different region of manuscript production (Occitania, the Veneto, and Northern France).[200] Here, the differences in the scores are more marked than in the previous cases. The two melodies in *R* and *G* have a similarity score of 0.541, while the version in *W* has a score of 0.151 with *R* and 0.187 with *G*.

[200] For additional discussion of melodic variants and divergent melodies, see Aubrey, *Music of the Troubadours*, 50-65.

	155010G	155010R	155010W
155010G	n/a	0.541	0.187
155010R	0.541	n/a	0.151
155010W	0.187	0.151	n/a

Figure 2.12: Statistical similarity of "Greu feira"

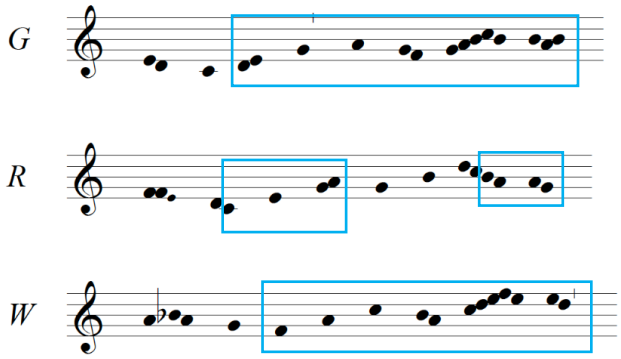
The three melodies have some similarities in their basic contour and motives that varies significantly in terms of pitch level and elaboration. As expected from the similarity scores, the melody in *W* shares slightly more in common with the melody in *G* than in *R*. The first phrase shows some similarities across all three manuscripts with several alterations (marked in red for similarities at pitch level, blue for similarities in transposition), while the second shows more consistency (see Music Example 2.16).



Music Example 2.16: First two phrases of "Greu feira"

All three of the first phrases begin with reiterated pitches. *W* begins a third higher than *G* or *R*; *R* has elaborations on two of the iterations of a'. The phrases then diverge, but with a shared motive appearing in *R* and *G* in different positions. In the fifth phrase, *W* and *G* are more similar

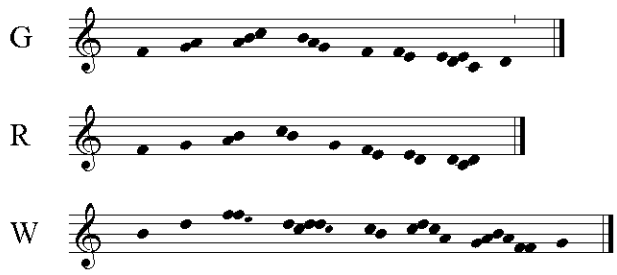
to each other than *G* is to *R*, although in the remainder of the melody *G* and *R* are more similar to each other than to *W*. Phrase five is compared below; note in particular the similarity in contour, though not pitch level, between the versions in *G* and *W* which is less present in the melody in *R* (see Music Example 2.17).[201]



Music Example 2.17: Fifth phrase of "Greu feira"

R's version of the fifth phrase has two components similar to that found in *G* and *W*: a triadic ascending motion and the final four pitches (marked in blue above). The final phrase has a similar contour in *G* and *R* through the shared rise from f' to c'', descent to c, with the final pitch on d'. *W*'s version is quite different; its relationship to the versions in *G* and *R* are limited to an overall arching contour that ascends a fifth then descends a seventh before rising a major second to the final pitch.

[201] Aubrey notes that troubadour melody concordances tend to share elements of contour but may differ in pitch-text alignment. Aubrey, "Literacy, Orality," 2362.



Music Example 2.18: Final phrase of "Greu feira"

These three melodies thus show unstable transmission of three melodies that, despite a high degree of difference, share enough specific similarities to clearly demonstrate their relationship to each other, rather than the version in *W* being considered a discordance. In this case, the similarity scores correctly reflect the lack of pitch similarities in the concordances (particularly that between the versions in *G/R* and that in *W*). The relationships shared through contour and motives at different pitch levels are not captured by the analysis, but are visible through close reading (as demonstrated above).[202] This points to the importance of combining different distant and close approaches to fully understand the musical characteristics of and relationships between the melodies.[203] LSA is thus effective at identifying melodies based on their pitch content, while requiring further analysis by the researcher to find similarities in transposition.

[202] I take two main approaches to statistical analysis of contour for the melodies. One begins with a transformation of the interval profiles of the melodies into two additional formats. The first represents the melodies as simply a series of ascending and descending motion to represent just the direction of melodic motion in the melody ('up down down up', and so forth). The second uses a less specific interval to find more general relationships by removing the quality from the profiles, leaving a string of interval sizes with their direction ('2+2-,' etc.).
[203] This is a similar position to that stated by Jason Stoessel in a 2016 lecture on digital musicology: Jason Stoessell, "The Relevance of Digital Humanities to the Analysis of late Medieval/Early Renaissance Music," Winterschool Digital Musicology, Tübingen, 18-19 November 2016.

Statistical Difference between Stanzas of Melodies in Manuscript G

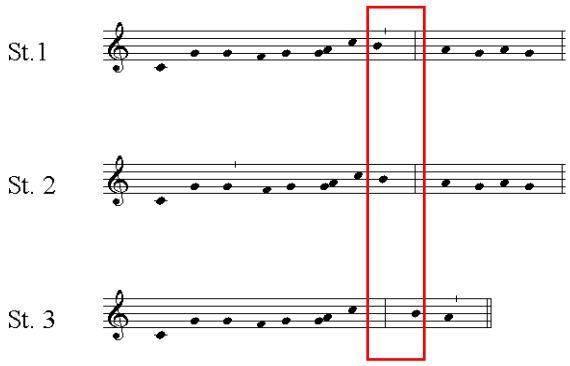
With the accuracy of LSA in identifying melody similarity demonstrated above, I apply the same technique to comparison of melodic phrases to discern the consistency or variation in the melodies in *G* that are transmitted with one or more phrases of the melody for the second stanza. This is an unusual occurrence for troubadour melody; those in *G* are the only cases in which melodies are included for any phrases after the first stanza.[204] Of the eighty-one melodies in *G*, a total of sixty-five include the first musical phrase of the second stanza.[205] Two additional melodies include notation for the entire second stanza: Bernart de Ventadorn's "Non es meravilla s'eu chan" (BEdT 70,031) and Peirol's "Per dan que d'amor m'aveigna" (BEdT 366,026).[206] Both of these provide melodies with text underlay for the entire first and second stanzas as well as the first phrase of the third stanza. "Per dan que d'amor" also includes the first two pitches of stanza 3's second phrase.

For this analysis, I ran two different sets of comparisons. The first examines the similarity of the two songs that have complete melodies for stanzas 1 and 2 and the first phrase of stanza 3. The second comparison tracks the similarity of the first phrases of stanza 2 to those of stanza 1 for the sixty-five melodies with only the first phrase of stanza 2 notated. For this analysis, I compared the melodies as series of individual pitches rather than within their pitch groups to

[204] One melody in *R* includes the first three pitches of the second stanza: Marcabru's "L'autrier jost'una sebissa" (BEdT 293,030). They are identical to the first three pitches of stanza 1.
[205] The list of concordances in Appendix B marks melodies with the entire second stanza notated with ** and melodies with the first phrase of the second stanza with * by their TMD ID.
[206] Steel discusses this phenomenon in his dissertation. See Steel, "Influences," 108-115. Steel suggests that the multiple stanzas preserved could mean that the melodies were slightly varied versions which would have been sung in polyphony. I do not agree that this is case, given the very similar (or even identical) nature of the melodies with their first two stanzas notated.

account for possible alterations in the text underlay between the first and second stanzas.[207] This essentially increases the similarity scores between the phrases because they are being compared through each of their individual notes without requiring the exact same appearance of pitches notated in a binaria or ternaria, etc.

The first and second stanzas of "Per dan que d'amor" are identical (with a similarity index score of 1) both in terms of their individual pitches and their grouping of pitches. The similarity score between the first phrase of stanza 1 and 2 and the first phrase of stanza 3 is 0.807. This difference in stanza 3 comes from the fact that the third phrase of "Per dan que d'amor" includes seven pitches instead of eight as in the first phrase of the first two stanzas. The first pitch of stanza 3, phrase 2 (b'), is the same as the eighth pitch of the first phrase of stanza 1 and 2 (see Music Example 2.19 below).



Music Example 2.19: Comparison of phrase 1 of stanzas 1, 2 and 3 of "Per dan que d'amor"

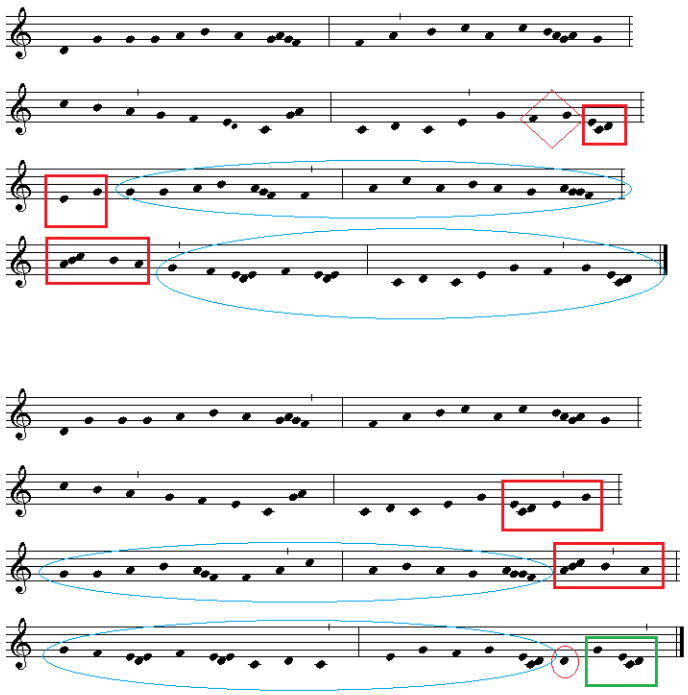
If the relocated eighth pitch is removed from the second phrase of the third stanza, it would begin on the same pitch as the other second phrases of the melody. This is significant because a similar

[207] For example, a phrase represented in Volpiano as "1---c---g---g---f--g---gh--k--j7---3" is compared as "c g g f g g h k j" rather than "c g g f g gh k j."

shifting of notes occurs in "Non es meravilla s'eu chan;" this could be the result of the scribe's response to changes in the number of syllables or the division of syllables in the text underlay, or could be the result of scribal error. As Steel notes, there are a few notational differences between the notation of stanza 1's melody and that used for stanza 2's. These primarily affect ternaria and binaria in the two versions of the melody which appear as different neume shapes in the two stanzas. This includes ternaria notated in one stanza with an oblique but in the other as three individual punctum joined by lines.

The first two stanzas of "Non es meravilla s'eu chan" (BEdT 70,031) are very similar in both pitches and pitch groups but have small differences. These include slight alterations in the order of pitches or neumes (see Music Example 2.3 below, marked in red rectangles), and identical series of pitches that appear in slightly different positions in the second stanza than the first (marked with blue ovals).[208] Only one pitch is completely new in the final phrase of the second stanza (marked with a small red circle); the final two neumes in that phrase (marked with a green rectangle) are a repetition of the last two neumes of the displaced phrase that spans the penultimate and final phrases of that stanza's melody, so that the second stanza ends on the same notes as the first stanza

[208] Steel comments on this shift and some notational differences between stanzas in his overview of this manuscript. Steel, "Influences," 108-109.



Music Example 2.20: Comparison of first two stanzas of "Non es meravilla" (BEdT 70,031)

Effectively, then, the omission of two pitches from the fourth phrase in the second stanza (f' g') causes a three-neume (usually also three-syllable) shift in the remaining phrases which the scribe (or the scribe of the exemplar) resolves in the final phrase by adding one pitch (d') then repeating the fourth and fifth neumes of that phrase to match the final two neumes of the first stanza's melody. This is thus a case similar to that discussed above in which the melody has been displaced for some reason (syllables or error) which has a resulting impact on the melody.

Regarding the sixty-five melodies with one phrase of the second stanza notated in *G*, a majority of those (thirty-seven) are identical to the first phrase of the first stanza. Of the rest, two have completely different incipits from that copied for the first stanza. In the case of Perdigon's "Tot l'an mi ten amor" (BEdT 370,013), this is a copying mistake in which the scribe copied the incipit for Perdigon's "Trop ai estat mon Bon Esper" (BEdT 370,014), which precedes "Tot l'an

mi ten amor," instead of providing the incipit for stanza 2 for "Tot l'an mi ten amor." There is no such explanation for the different incipit for the second stanza of Aimeric de Pegulhan's "Atressi·m pren com fai al jogador" (BEdT 10,012); the only melodic passage in the repertory which matches that incipit is that of Bernart de Ventadorn's "Lanquan foillon bosc e garric" (BEdT 70,024), a melody which is unique to *W*.[209] For the remaining twenty-six melodies, the differences are typically small, such as differences in accidentals or missing pitches at the end of phrases, such as where the phrase was not finished or the second stanza line had fewer syllables than the first.

The second stanza melodies in *G* thus provide a unique opportunity to view all or part of second stanzas of the melodies to evaluate the ways in which the melody changed or stayed the same between stanzas. Overall, the group of melodies with the second stanza notated (in all or in part) demonstrate the close similarity between the melody used for the second stanza and that for the first, supporting the relationship between the melodies sung for the first stanza and subsequent ones. Further, the copying of the incipits reveals one clear case of scribal error with the copying of the incipit from "Trop ai estat mon Bon Esper" as the incipit for stanza two of "Tot l'an mi ten amor," while also raising the intriguing question of how the discordant incipit found for the second stanza of "Atressi·m pren com fai al jogador" is a nearly identical match for the first seven neumes of a melody only found in *W*.

[209] The text of the song appears in two Occitanian sources, *C* and *E*, which are text-only sources.

Conclusion

Text analysis tools, as demonstrated in these case studies, provide several ways of analyzing and comparing the Volpiano-encoded melodies transcribed for this project that are outside of the scope of the search features included in the TMD. They are particularly useful in evaluating features of musical style that lend themselves to computation (such as counting the number of occurrences of a particular feature or establishing a numerical similarity index between the melodies). Using these approaches, I established the specific characteristics of melismas found in the works of Riquier and compared them to the melismatic writing found in the broader repertory. Concordance analysis allowed me to identify all melismas in the corpus and compare their specific features while also communicating aspects such as the position of melisma through the use of distribution plots, as well as through transformed versions of the melody created through the TMD's Melody Analysis Tool, discussed in the following chapter.

Drawing on these methods of analysis, I am able to state not only that Riquier's melodies are more melismatic than those attributed to other troubadours (with a few exceptions), but also that they vary in position as well as length from those of other troubadours, and to what extent. Similarly, comparing the melodies with document similarity analysis allows greater specification of the differences in pitch content between concordances through the expression of two melodies' similarity as a single value that can be easily juxtaposed to others. This type of analysis can also be used for similarity comparison within individual melodies, as demonstrated in the comparison of melodic phrases in *G*. Further, LSA could also be used to discern similarity between works by the same troubadour, within the same genre, or to answer other research questions relying on determining relationships between songs. This type of analysis, like all distant approaches, works best when joined with close analysis of the melodies to compare the

pitch-level relationship calculated by the LSA script to the intervallic profile of the melody to find possible similarities in transposition.

Text analysis thus offers methods for evaluating musical style using computational processes without requiring development of Volpiano-specific analytical software. In this case, taking a digital musicological approach to the melodies allows a higher-degree of specificity and greater control of the musical features of troubadour song both by allowing the melodies to be read by tools designed for comparison and by making it possible to transform the melodies into forms that simplify comparisons based on intervals or neume lengths.

Chapter III

Pitch and Interval-Based Analytics

In this chapter, I present three case studies in which I analyze the musical features of troubadour song using computational methods. Each case study examines a particular aspect of or question about the troubadour repertory using the Melody Analysis Tool, described in Chapter I.[210] Numerical and statistical data derived from the corpus of encoded melodies, distinguished by source, author, genre, and other parameters, are combined with traditional approaches to investigate the stylistic features of the melodies in specific contexts. In the first case study, I compare the features of the third and fourth generations of troubadours defined by Aubrey to challenge the usefulness of such a classification to establish chronological trends in style. Case Study 2 approaches the question of pitch organization in this repertory, including the degree to which the modal structures of church modes are reflected. The final case study reviews the method and expands the results of the statistical analysis used by Matthew Steel in his 1989 dissertation to discuss text-setting style and intervallic frequency.

Case Study 1: Musical Style and Troubadour Generations

Scholars have approached the troubadour melodies from a variety of perspectives to discern trends, styles, and relationships within the corpus. In her monograph on the troubadours, Elizabeth Aubrey divides the repertory into six overlapping generations based on the known periods of activity of the troubadours. These generations, with their time ranges, appear below in

[210] For a description of the Melody Analysis Tool, see Appendix C. A table of these musical features is included in the TMD.

Figure 3.1, which also shows the number of troubadours assigned to each generation, the length of each generation in years, and the number of years that overlap between generations.[211]

Generation	Time Period	No. of Troubadours	No. of Melodies	Length of Generation in Years	Overlap with Previous/Following
1	1120-1150	3	11	30	-/10
2	1140-1180	4	45	40	10/20
3	1160-1210	16	126	50	20/30
4	1180-1240	13	69	60	30/30
5	1210-1255	4	5	45	30/25
6	1230-1300	5	58	70	25/-

Figure 3.1: Summary of Aubrey's troubadour generations

Aubrey and others draw conclusions about musical style based on these generations to describe when particular traits changed during the period of troubadour activity; however, while the generations can be useful in discussion of some features of troubadour song, particularly when searching for evidence of interaction between troubadours who were contemporaries, they have limitations when applied to evaluation of stylistic changes over time.[212] I thus assess a selection of claims based on analysis by generation through computational analytical approaches to establish the musical characteristics of the third and fourth generations of troubadours as defined by Aubrey to determine what aspects of style vary between these two generations and to what extent. Analysis of their musical characteristics affords a comparison of their features, including their boundary pitches, ranges, and average pitches per neume (PPN, used to compare the syllabic or melismatic character of the melodies as described in Chapter I). To compensate for the difference in size of the repertory from these generations, the comparisons are based on the

[211] The information for these generations comes from Aubrey, *Music of the Troubadours*, 37-39. Granet is not included in Aubrey's study because a fragment too short for analysis is the only surviving melody attributed to this troubadour. From his known dates of activity (fl.1240-1257), he would be assigned to Aubrey's sixth generation and be the fifth troubadour in that group.

[212] For a recent study focused on ten fourth-generation of troubadours, see Chaillou, *Faire lo motz*.

percentage of each generation's melodies a particular feature represents rather than simple totals. The data used for this comparison is drawn from 312 songs attributed to a troubadour which are not too fragmentary for analysis.[213]

Initial pitches in songs from these two generations range from c'-g'', with each pitch in that range opening one or more songs in both generations. The fourth generation shows a more balanced distribution of use across a variety of pitches, as seen in Figure 3.2, which presents each generation's initial and final pitches as percentages.[214]

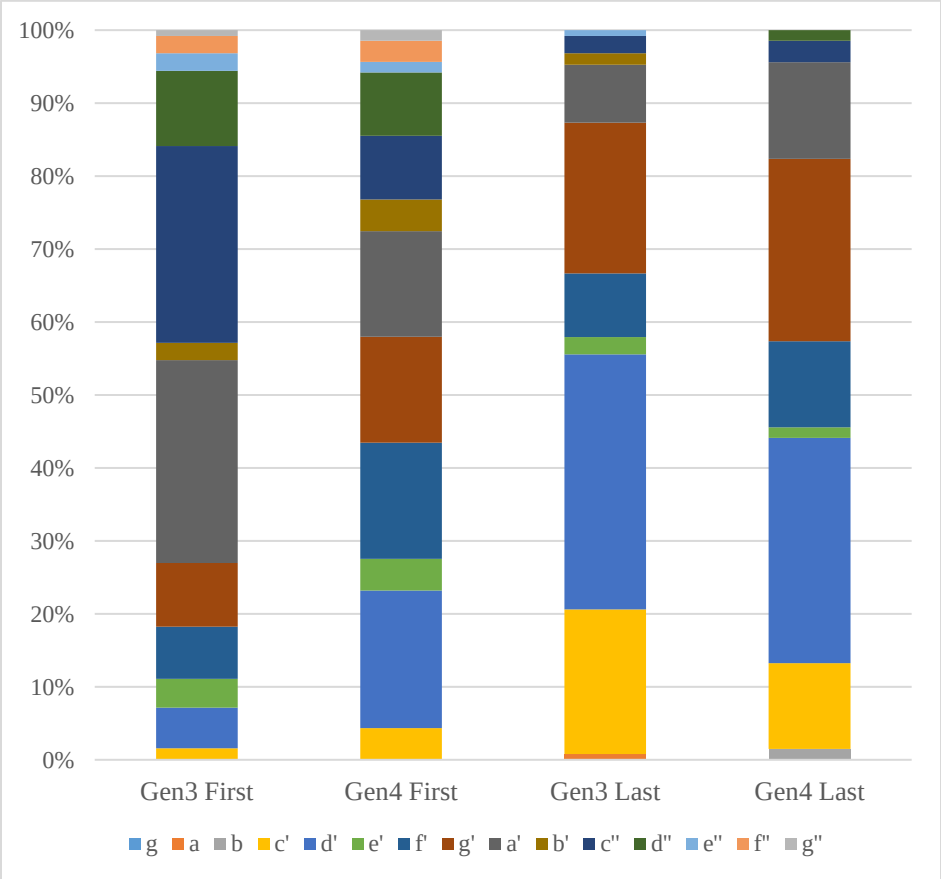


Figure 3.2: First and last pitches in third and fourth generations

[213] The melody concordance in Appendix B marks all melodies I considered too fragmentary for this type of analysis.
[214] Visualizations of all the musical characteristics discussed in the chapter for both generations are included at the end of this case study.

The most common starting pitches in the third generation are a’ and c’’ with significantly smaller representations of the other pitches. Twenty percent of fourth generation melodies start on d’, less often than either of the third generation’s two most common initial pitches. The division of final pitches is more consistent than that of initial pitches between the two generations. The range for final notes is a twelfth, as it was for initial pitches, but the range is shifted a third lower to a-e’’. Both generations show prominent use of c’, d’, and g’, with a similar rate of occurrence by f’ and h’. Unlike the initial pitches, for which both generations had the same range of pitches represented, three more pitches (a, b’, and e’’) are found as final notes in the third generation that are not found in the fourth generation, and two pitches (b’ and d’’) appear in the fourth generation but not the third.

A similar division of highest and lowest pitches exists in both generations. The lowest pitches overlap more in their rate of appearance between the two groups than the highest, with songs reaching a wider variety of pitches at their apex in the fourth-generation melodies. The combined range of highest notes is a’-b’’. The fourth generation includes three highest pitches not found in the fourth generation (a’, b’-flat, and b’); the third generation has the highest pitch found in the troubadour repertory, one pitch higher than the highest found in the fourth generation. The two generations share d’ as the most frequent highest note, but it appears in over forty percent of melodies from the third generation, compared to twenty-seven percent in the fourth.

The lowest pitches are more consistent between the two generations. These span an octave from g-g’. Each of the eight pitches found as lowest notes appear in both generations in a similar ratio. The third generation tends to use more of the lowest three pitches overall than the fourth generation. Both generations have c’ as the lowest pitch for over fifty percent of their

melodies, with f’ as the next-most frequently appearing pitch. Based on the four boundary notes of these melodies, the two generations are particularly similar in their usage of lowest and final notes, but they show a greater degree of difference in highest and initial pitches.

Both the third and fourth generation use twelve different ranges; a total of sixteen range intervals appear in all of the melodies from both generations (a majority of the nineteen found in the corpus overall). Rates of frequency between the two generations are quite similar for some intervals but markedly different for others. As demonstrated in Figure 3.3, the fourth generation has the largest difference in ranges of the two (from a minor sixth through a minor fourteenth). Both generations have a similar proportion of octave, major and minor ninth, major and minor tenth, and minor eleventh ranges. There is thus a greater degree of similarity overall in the range usage of the two generations because the majority of the melodies fall into those shared categories.

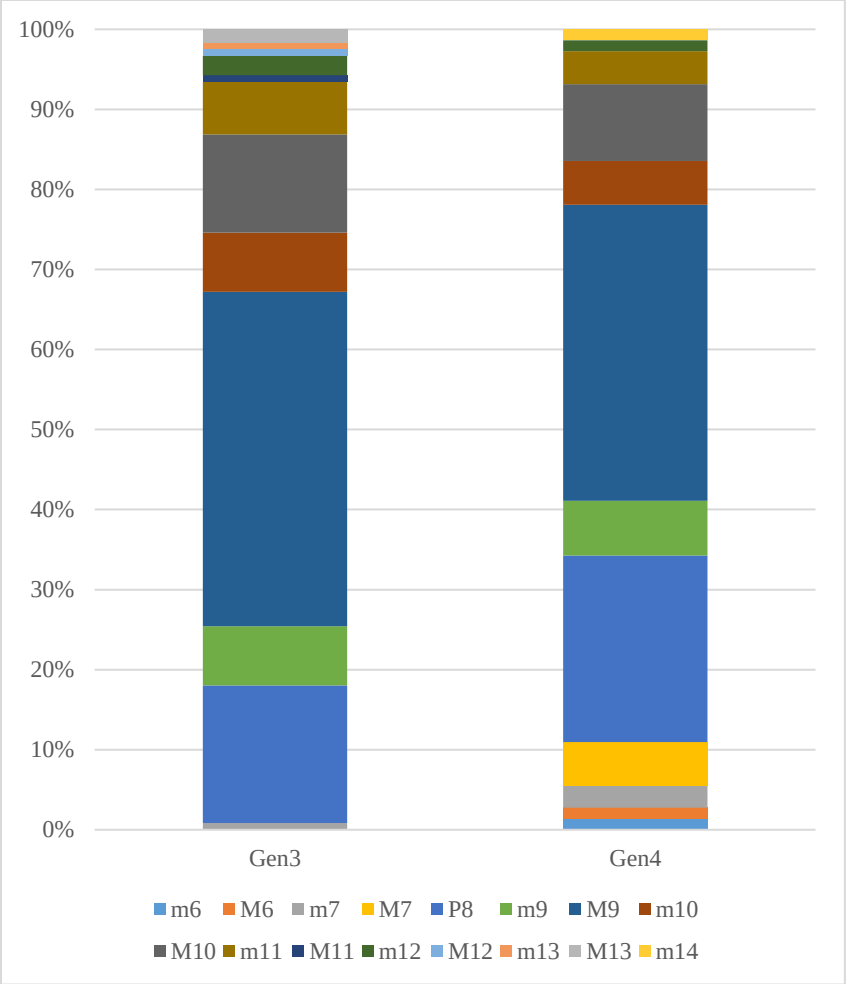


Figure 3.3: Range intervals in third and fourth generation melodies

The fourth generation includes more melodies with smaller ranges compared to the third, which includes a greater number of melodies with large ranges.

Turning to the intervallic content of the melodies, I compared the first and last interval usage by the two generations to demonstrate their differences in opening and closing interval appearances, seen in Figure 3.4:

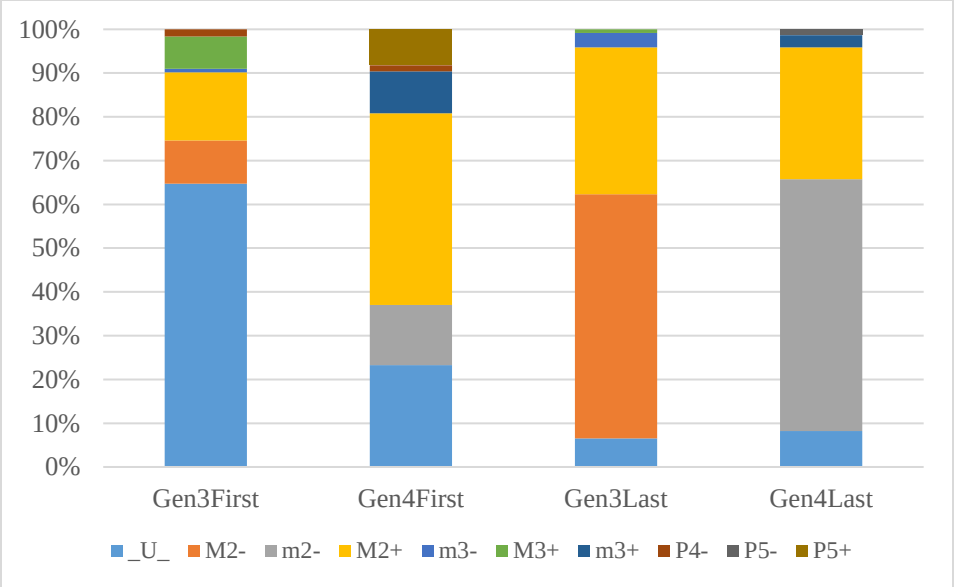


Figure 3.4: First and last intervals in third and fourth generations

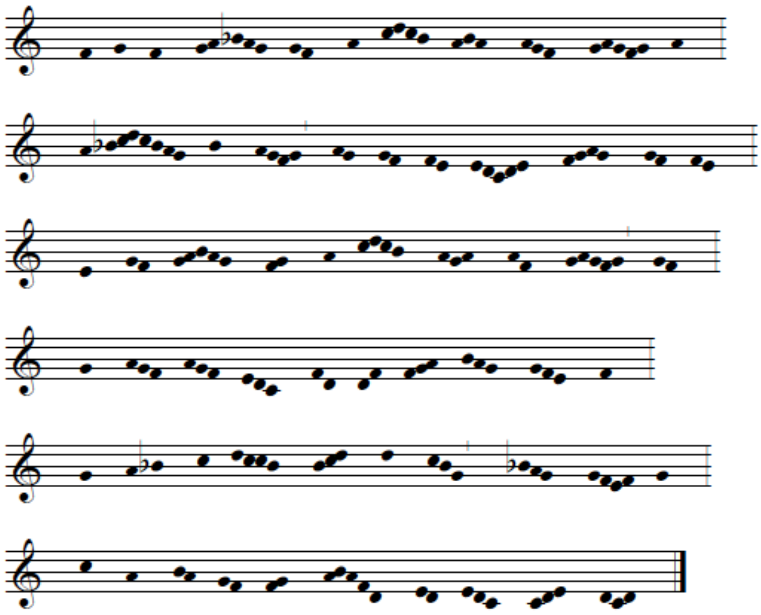
Final intervals tend to be one of three most common intervals in both generations: unison, major descending second, and major ascending second for the third generation, and unison, minor descending second, and major ascending second for the fourth. By contrast, the first intervals are markedly different between generations. Over sixty percent of third-generation melodies open with a unison, compared to twenty-three percent of fourth-generation melodies. Three opening intervals appear in the third generation that do not in fourth generation melodies (M2-, m3-, and M3+); three different intervals appear in the fourth generation and not the third (m2-, m3+, P5+).

After detailing aspects of the pitch and interval content of the melodies, I compared their larger structure through their length. The melodies from these two generations vary significantly in their length by number of phrases. Nearly all of the melodies in the fourth generation have seven to nine musical phrases (ninety percent), but only half of the melodies from the third

generation are those lengths. Ten different lengths (by number of phrases) are found in the third generation, while the fourth generation has only seven.

One of Aubrey's broad conclusions about generational changes in musical characteristics is that the melodies become more melismatic overall over time and that melismas appear in a wider variety of positions instead of appearing primarily at cadences.[215] Degree of melisma use is compared here through the pitches per neume (PPN) values discussed previously. Focusing on the third and fourth generations specifically, the third generation's average PPNs range from 1.084-2.266, while the fourth's range from 1.053-2.574. The fourth generation thus includes melodies with a wider range of text-setting styles than the third generation, despite the larger size of the third-generation repertory. The most syllabic song in the fourth generation is also that of the entire repertory, the Monk of Montaudon's "Mot menueya soauzes dire" (BEdT 305,010), presented in Chapter I (see Music Example 1.2). The fourth generation also has the most melismatic melody not attributed to Guiraut Riquier in the corpus (see Music Example 3.1), Uc de Brunet's "Coindas razos e novelas plazens" (BEdT 450,003), with a PPN of 2.574:

[215] Aubrey, *Music of the Troubadours*, 235.



Music Example 3.1: Melody for "Coindas razos e novelas plazens"

Based on these comparisons, the melismatic quality of melodies does not significantly increase between the two generations, as there is a wider range of text-setting styles in the fourth generation (both syllabically and melismatically) than that found in the third generation. Aubrey also states that the position of melismas changes, so that they appear primarily at cadences earlier in the tradition then, over time, appear in a wider variety of positions.[216] I compared the placement of melismas using distribution plots, a visualization method outlined in Chapter I, which shows the locations of each melisma of a particular length on a rectangle representing the length of the melody. The comparison here focuses on melismas of six or more notes to limit the discussion to longer melismas.[217] I chose to limit the corpus for this part of the analysis because

[216] Aubrey, *Music of the Troubadours*, 235.
[217] The plots themselves can be found in the TMD. They are grouped by melisma length and individual troubadour; the plots are individually labeled with each song's catalog number.

of the significant increase in the number of melismas when five- and four-note melismas are included.

Six-note melismas are much more frequent than longer ones: sixty-six melodies have at least one six-note melisma. Of these, twenty are third-generation and twelve are fourth-generation. Four third-generation melodies have this length melisma in their first half (only one melody has two six-note melismas, both appearing in the first half of the melody). Four of the fourth-generation melodies have multiple six-note melismas (two to four per melody); two of those, as well as one melody with a single six-note melisma, have melismas in the first half of the melody, while the others appear closer to the end of the melody. Fourteen melodies in the entire corpus have a melisma with seven pitches (two from the third generation and four from the fourth). Both third-generation melodies have a seven-note melisma once near the end of the melody, while the fourth generation's melismas appear one to two times in the second half of the melodies in all four cases. Eight melodies in the repertory overall contain a melisma with eight pitches. One of these is attributed to a third-generation author and two to fourth-generation troubadours. One melody from each generation has melismas placed near the end of the melodies; the second melody from the fourth generation, by Uc Brunet, has the melisma near the beginning of the melody instead.[218]

These comparisons indicate an increase in the number of six- to eight-note melismas between the third generation and the fourth, which fits with Aubrey's description of an overall increase of melismatic melodies over time. Melismas do tend to appear earlier in the fourth-generation melodies, but both generations include examples of melismas that appear earlier in

[218] "Coindas razos e novelas plazens" (BEdT 450,003).

the melody. In the tradition overall, long melismas appear at various points within a melody in each of the generations except for the fifth (likely because of the small number of melodies from this generation); the most marked increase in usage comes with the melodies of Riquier in the sixth generation.[219]

Based on the musical characteristics examined here, the melodies surviving from the fourth generation of troubadours display, overall, greater diversity in these aspects of their musical style than the third, despite the smaller number of melodies extant from the fourth generation and the larger number of troubadours represented in the third generation. Certain musical features appear consistent in both generations' musical tendencies, particularly in the frequency of lowest and final pitches and of final intervals. The analysis here thus generally agrees with Aubrey's large-scale trends proposed for the repertory in her study. In the case of the third and fourth generations, however, the degree of difference, although discernable, is typically small.

To more precisely represent the styles of text-setting seen in the melodies over time, I visualized the PPN values for the melodies along with their proposed end dates (based on the known period of activity of the troubadour the melodies are attributed to).[220] This type of representation allows both individual traits and overall trends to become apparent by presenting the specific PPN values with their rough chronological position in troubadour melodic composition. The claim that the corpus overall becomes more melismatic between earlier generations and later ones is, mathematically, correct. This is represented by the trend line in

[219] For a detailed discussion of melismas in Riquier's melodies specifically, see Chapter II, Case Study 1.
[220] These dates are, of course, not absolutes as there is considerable ambiguity about the biographies of the majority of troubadours; however, any chronological discussion must utilize a timeline, even if imperfect.

Figure 3.5, which has a slight incline, increasing from approximately 1.5 pitches per neume in 1126 to 1.75 in 1322.

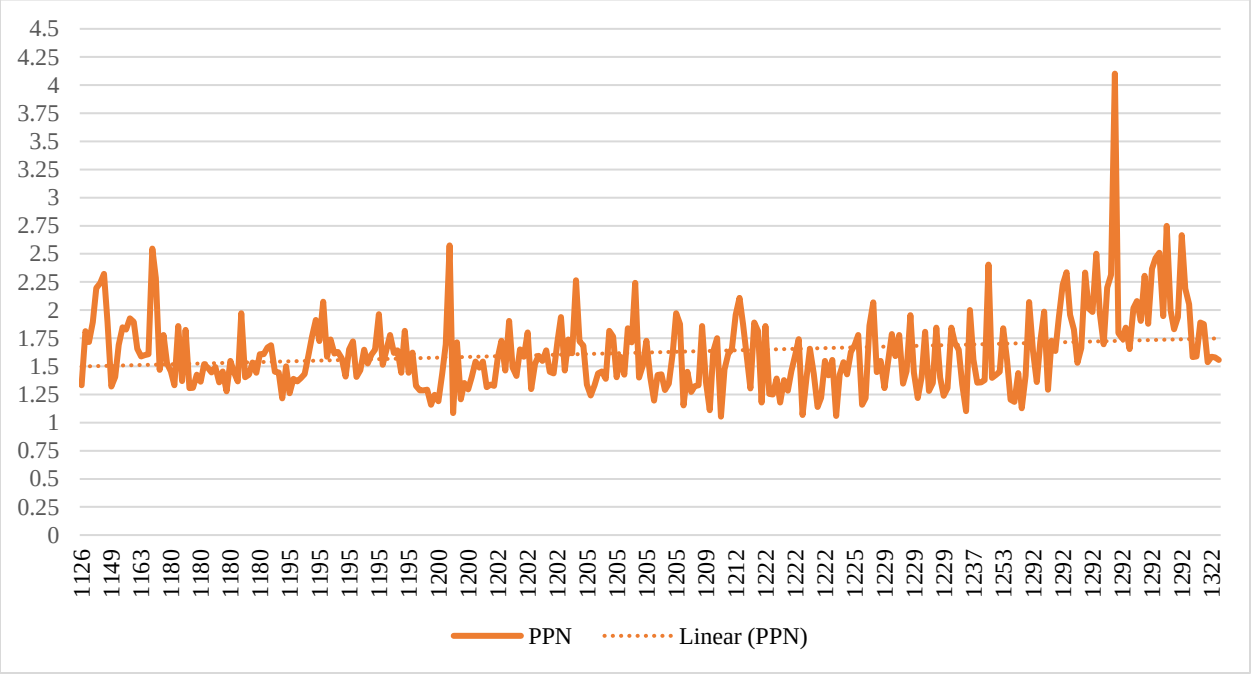


Figure 3.5: Chronological PPN values

However, if the latest two troubadours (Riquier and Matfre) are removed from the calculation, there is actually an overall downward trend from approximately 1.7 to 1.48 (see Figure 3.6).

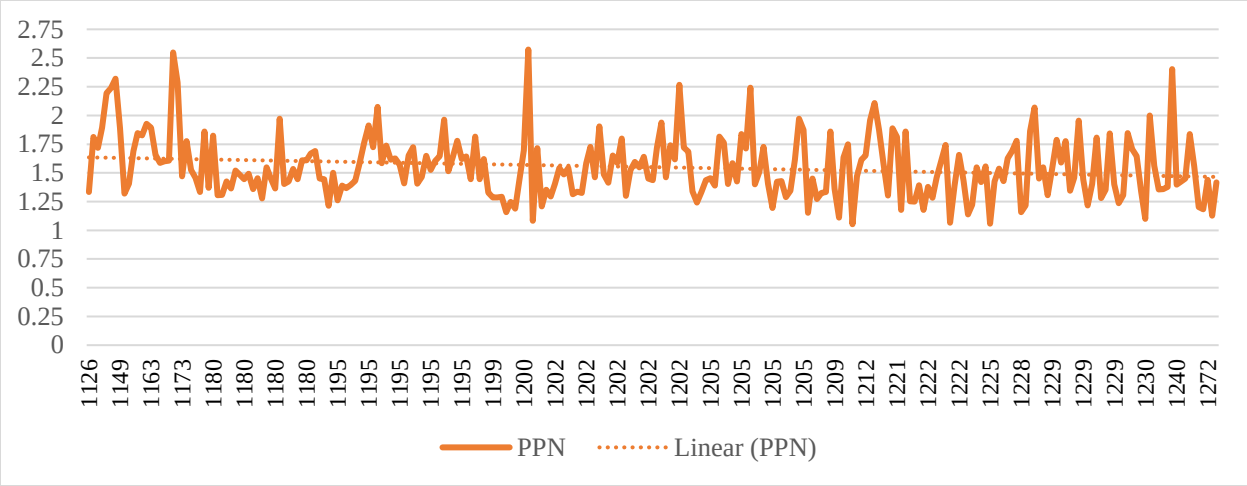


Figure 3.6: Chronological PPN values (without Riquier)

Stylistic outliers who contributed a significant portion of the overall surviving corpus (like Riquier) can thus significantly alter general trends because of the sparse melodic record of troubadour song. Despite this, information can still be gleaned from this type of analysis. A specific range of PPN values encompasses a majority of melodies until Riquier appears at his end date of 1292. Melodies with a PPN between 1.25 and 1.75 are most common both overall and at smaller divisions of time. Outliers occur throughout the repertory, but conclusions can still be effectively drawn from a chronology-based approach to analysis. However, the generational division from Aubrey, while useful for investigating aspects of troubadour biography, limits broad scale analysis because two of the generations are not large enough to discuss style within their subgroup (which also prohibits their inclusion in broader chronological comparisons).

Analysis of the extent corpus thus benefits from a different division for discussion of chronological change. It is important for the sake of analysis that each subgroup of the repertory contains a roughly similar number of melodies. This arrangement permits observation of stylistic tendencies within each group instead of having one or more subsets of melodies that are

insufficient for analysis. A rough division of the repertory into thirds (approximately one hundred melodies per group without the twenty-seven anonymous songs) based on the end of each troubadour's known period of activity would result in periods from 1125-1200 (A), 1200-1225 (B), and 1225-1325 (C). This divides the songs into those composed in the twelfth century, early thirteenth century, and mid-thirteenth to early fourteenth centuries. Such a division also demonstrates the extent to which the surviving melodies are concentrated chronologically (as well as the distribution of songs across the sources with respect to their chronology; see Figure 3.7).

Period	**Dates**	**Total Songs**	***G***	***R***	***X***	***W***
Anonymous	-	27	0	0	2	15
A	1126-1199	98	30	34	7	23
B	1200-1225	109	37	48	12	11
C	1226-end	105	14	79	2	6

Figure 3.7: Songs by period and four main manuscripts

However, the range of styles within each of these larger periods is partially obscured when reduced to these three chronological periods. The most noticeable trend overall in musical features as compared by this tertiary division is a remarkable consistency in style.[221] I thus propose dividing the corpus into six groups based on troubadour end date (each group in this division has at least forty melodies). This approach has an advantage over that of Aubrey in that each period has a sufficient number of melodies for analysis, but is still granular enough that the individual traits of melodies are reflected.

[221] Visualizations of stylistic features for this tertiary chronological division of the repertory can be found in the dissertation resources in the TMD.

The small number of extant troubadour melodies makes it difficult to draw broad conclusions about changes over time as the individual style of troubadours with a significant number of melodies can greatly alter perceived trends in musical features (as demonstrated previously with the impact of Guiraut Riquier's melodies on the end of the period of troubadour activity).[222] Smaller subdivisions of the repertory better reflect the variety in musical style found in the surviving melodies; however, an division which results in some groups having only a few melodies makes trends difficult, if not impossible, to perceive. When the corpus is divided into six roughly equal groups based on the end date of their attributed troubadour (a time period of roughly two hundred years), the resulting division has at least forty melodies in each period (see Figure 3.8). This division is not based on hard chronological divisions drawn where there are clear points of stylistic change; instead, it is aimed at grouping melodies into subsets which each contain sufficient melodies to permit discussion of stylistic features at a particular time of troubadour activity.[223] The melodies are grouped into those composed during the mid-twelfth century (A.I), late twelfth century (A.II), beginning of the thirteenth century (B.I), early-thirteenth century (B.II), mid-thirteenth century (C.I), and late-twelfth to early-fourteenth century (C.II).

[222]As noted previously, Riquier has forty-eight melodies extant, making up fourteen percent of the surviving melodies.

[223] These divisions were made by making a list of melodies in chronological order by the last known date of activity of the troubadour they are attributed to, which was then divided into as equal of subgroups as possible with the range of end dates. For a list of the troubadours with their dates used for this process, see Appendix A. The concordance of editions of the melodies in Appendix B includes their period assignment as well.

Period	Dates	No. of Troubadours	Number of Melodies	Length in Years
A.I	1126-1180	7	55	55
A.II	1181-1199	5	43	19
B.I	1200-1205	8	43	6
B.II	1206-1225	10	66	15
C.I	1226-1275	11	52	50
C.II	1276-1322	3	53	46

Figure 3.8: Number of melodies and troubadours by period

The six periods all contain at least five troubadours for all the periods except C.II, which is comprised almost entirely of the works of Riquier. The smallest number of melodies in a period is forty-three with a maximum of sixty-six, compared to the range from five to one hundred and twenty-six in Aubrey's generations. The range of years in each group is representative of the concentration of troubadour songs with extant melodies at the end of the twelfth and the early thirteenth century. The two-part names of the periods reflect a larger-scale connection between those two groups. Both A periods contain melodies composed during the twelfth century. The B periods cover the early thirteenth century (divided internally roughly into the period before and after the Albigensian Crusade based on troubadour end dates). The two C periods coincide both with the aftermath of the crusade and the appearance of known written sources. These are distributed fairly evenly across the main four music manuscripts except for the second and last groups: C.II contains melodies only preserved in *R* and *W*, and *X* is the only source without melodies from A.II.

Period	Dates	No. of Melodies	*G*	*R*	*X*	*W*
A.I	1126-1180	55	12	20	7	15
A.II	1181-1199	43	18	14	0	7
B.I	1200-1205	43	14	16	7	5
B.II	1206-1225	66	23	32	5	6
C.I	1226-1275	52	14	30	2	5
C.II	1276-1322	53	0	48	0	1[224]

Figure 3.9: Counts of melodies by period and manuscript[225]

The distribution of pitches that appear as first notes across these six time periods show a similar usage of c', d', e', f', and g', with these central pitches making up thirty-five to sixty percent of the first notes in each group. In four periods (the earliest, A.I, and the last three, B.II, C.I, and C.II), a' comprises thirty percent of appearances on its own, but less than fifteen percent in A.II and B.I. Period B.I has the largest percentage of pitches higher than a'; it also has the highest representation of c'' (twenty-five percent) and d'' (twenty percent) in any of the periods.

The distribution of final pitches has several clear differences from that of first notes.[226] The most common final pitch, d', makes up from twenty-five to fifty percent in each period, with the highest rate of appearance in the last time period, C.II. The four pitches found most often as first pitches comprise an even higher percentage of final notes, making up eighty to ninety-five percent of notes in each subgroup of melodies. A.I, A.II, and C.I have very similar pitch usage, with the pitches c'-g' making up eighty percent of their final notes. A.I and C.I also share the

[224] The song from this period in *W* is "Bela m'es la votz autana" (BEdT 124,005). The BEdT gives an end date for composition of this song by 1229-1230 based on the end date for the Old French romance *Guillaume de Dole*, which cites the song. ("124,005" in BEdT, accessed 15 November 2019) The song was thus composed at least thirty years prior to *W*'s compilation and was clearly known to French audiences. The BEdT also notes that scholars have debated the attribution to Daude de Pradas as *Guillaume de Dole* is believed to have been written closer to 1200, prior to his period of activity. ("124,005" in BEdT, accessed 15 November 2019).
[225] The last period has no melodies represented in *X* because of its early date of compilation. Similarly, *G* was made around the same period as C.II and has no songs by those troubadours.
[226] Visualizations for each of the musical features discussed here are located at the end of the case study.

only appearances of a d'' final; B.II contains the only melody with a final on e''. The periods have final pitches that span an octave (A.II, B.I, C.II) or ninth (A.I and B.II) except for C.I, which spans a tenth. The two least common final pitch classes, E and B, appear in all of the periods; the higher octave (b' and e'') is found in A.I and B.II, respectively. In this instance, a' makes up only fifteen percent or less of appearances, half that seen in first pitches; the representation of higher pitches is typically lower among final pitches as well. In each of the comparisons by period above, the first note division includes a greater percentage of higher notes than the final notes division, with some periods having a more striking difference in use, such as B.I. These charts thus demonstrate the overall trend among troubadour melodies to begin higher in the troubadour pitchscape and end in the lower range, while also showing details about the actual pitches used at different points of troubadour activity.

The highest pitches found in each group of melodies reflect a tendency for d'' to be the uppermost point of melodies, particularly in A.II, B.I, and C.II where it makes up at least forty-five percent of highest notes. A.II has the smallest number of different pitches appearing as the apex of melodies, spanning a seventh, while A.I has the largest number (spanning a tenth). The highest pitches in the repertory, b''-flat and b'', appear in A.I, A.II, and B. II. The highest pitch found in the last two periods is a''.

Comparison of the pitches that appear as lowest notes shows a consistent distribution in both A.I and A.II before varying pitch usage in the later periods. C.I aligns closely with the division of lowest notes seen in the first two periods but with the inclusion of e' as a lowest pitch. Both B.I and B.II have the only appearances of the lowest pitch, g', in the corpus. C.II is the most distinct from the other periods with almost ninety percent of the melodies in that group descending to c', compared to forty to fifty-five percent in the other periods. The span of pitches

found as lowest notes in each period is smaller than that usually seen with the other parameters; A.II and C.I both have lowest pitches within the range of a sixth, while A.II and C.II both span a seventh and B.I and B.II span an octave.

Range intervals for the six periods show that the most frequent ranges overall (octave and ninth) are found in eighty percent of the melodies from the first and last periods, with a slightly smaller representation in the internal periods. B. I and C.I have the smallest percentage of ranges that are octaves or ninths (less than sixty percent). B.I has the highest percentage of melodies that range a tenth (C.I has the second highest); however, C.I contains melodies with some of the smallest ranges overall, while B.I has no melodies with a range smaller than an octave.

The six periods vary widely in the usage of first intervals of melodies. In this case, I compare the intervals without quality but with direction. All of the troubadour melodies open with an interval between a unison and a fifth, with the unison and ascending second most common overall. There are marked differences between nearly all of the periods; the most similar are B.II and C.I, which include melodies that open with the same six intervals. Descending thirds only open melodies in the first two periods (one in each). Ascending thirds appear in all of the periods with the largest representation in A.I. Perfect fourths are uncommon as opening intervals in either direction. An ascending fourth opens just one melody in the corpus, the version of Bernart de Ventadorn's "Non es meravilla s'eu chan" (BEdT 70,031) found in *G*, from A.I.[227] Descending fourths are found as first intervals in A.II (one melody), B.II (one melody), and C.I (two melodies). A.I, B.II, and C.I are the only periods which have at least one melody that opens with an ascending perfect fifth; descending fifths only open melodies in C.II.

[227] The version of this melody in *W* opens with an ascending fifth instead of an ascending fourth.

When the last intervals are compared by period, there is a much more consistent representation of intervals than found for first intervals (see Figure 3.10).

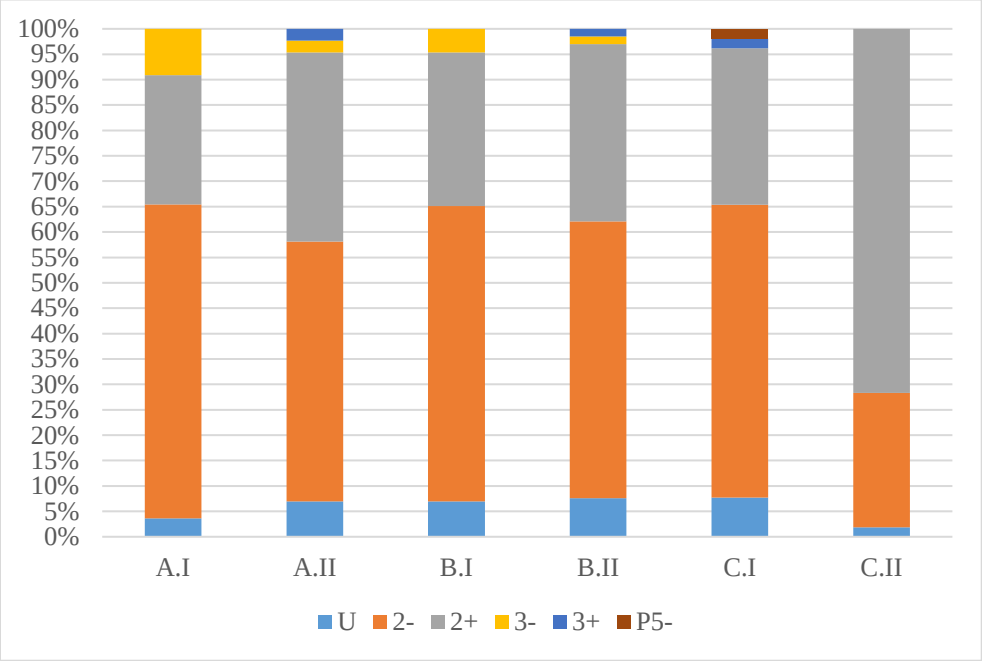


Figure 3.10: Last intervals by period

Only four different intervals appear as final pitches in the songs examined here. Unisons, one of the most frequent first intervals, are uncommon final intervals; they do still appear at least once per period. Seconds account for at least ninety percent of final intervals in each of the periods. Descending seconds are more common than ascending ones in every period but the last, C.II. Thirds are even less common than unisons, appearing most often in A.I; the first four periods each have at least one melody that ends with a descending third, while a final ascending third appears in A.II, B.II and C.I. There are no cases of final perfect fourths in either direction, but one melody in C.I ends with a descending perfect fifth, Guillem Augier Novella's "Ses

alegratge" (BEdT 205,005). Overall, two pairs of periods show the most similarity two each other, A.I/B.I and A.II/B.II, while C.II is the most distinct from the others.

The length of melodies in each period by number of phrases also shows a fair amount of variation between periods. As noted previously, melodies most often have eight, nine, or ten phrases in the repertory overall. These are still very common in all periods, but seven phrases are comparatively as common in A.I, A.II, B.II, and C.II, and the first period does not have any melodies that are ten phrases long. B.I has the most variety with nine different melody lengths; C.I has only five. Melodies with fifteen and sixteen phrases only appear in B.I, while C.II has the only appearances of fourteen-phrase melodies.

Comparison of the six periods by the average pitches per neumes follows in Figure 3.11. The first and last groups of melodies are the most melismatic, with C.II significantly more melismatic than the other periods because it contains all of the melodies by Riquier.

Period	Dates	Count	Avg PPN
A.I	1126-1180	55	1.623
A.II	1181-1199	43	1.550
B.I	1200-1205	43	1.551
B.II	1206-1225	66	1.503
C.I	1226-1275	52	1.515
C.II	1276-1322	53	1.973

Figure 3.11: Average PPN values by period

The internal four periods have very similar averages, with A.II and B.I having almost identical values. The least melismatic period here is B.II, which also has the greatest number of melodies of the group (the next largest group is A.I, the second-most melismatic). The chronological trend seen here shows a decrease in the extent of melismatic writing in the early thirteenth century

which increases only slightly through mid-century. Then, the final fifty years of troubadour activity show a significantly higher rate of melismatic text setting with the songs of Riquier (which also coincides with the rise of greater authorial intent in the recording of the melodies). Comparison of text-setting styles through this division thus refines that of Aubrey by identifying, instead of a general overall increase in melismatic writing over the course of the tradition, a slight decrease in melismatic writing in melodies at the turn of the thirteenth century before an increasingly sharp rise in melismatic textures by the mid to late thirteenth century.

From the comparisons drawn based on the stylistic features here, one of the most noticeable tendencies is that the B.I melodies, from the first years of the thirteenth century, have the most differentiating features from the other periods overall, followed by the final period, C.II, which spans the end of the thirteenth century and the first decades of the fourteenth. There is one feature for which the first and final periods have the most in common: the degree of melismatic writing. One observable pattern is a tendency towards melodies with a larger number of phrases (and thus poetic lines) in the A.II and B.I melodies from the late twelfth and very early thirteenth centuries, so that melodies grew longer (overall) over roughly the first century of troubadour activity, then returned to slightly shorter melodies until the last quarter of the thirteenth century. A.II and B.I also share the most similar rates of appearances for first intervals of melodies.

On the broadest scale, it can be noted that the different features of the troubadour pitchscape examined here show similarities across different time periods, so that two periods may be most similar with respect to one or two features, but be different with respect to others, instead of seeing two or more time periods which are consistently most similar (or, consistently most different). This approach to dividing the repertory to facilitate chronological comparison thus has an advantage over that of Aubrey in that each period has a sufficient number of

melodies for analysis, but does not group the melodies into such large groups that the high degree of individuality between troubadours and melodies is obscured. The features transparent in the revised division allow a more nuanced review of changes in style over time, such as the revision of Aubrey's description of a fairly consistent rise is melismatic textures between generations described above. My analysis of the periods within this division thus both establishes the features of the repertory at specific points of the tradition while also permitting comparison of stylistic features over time.

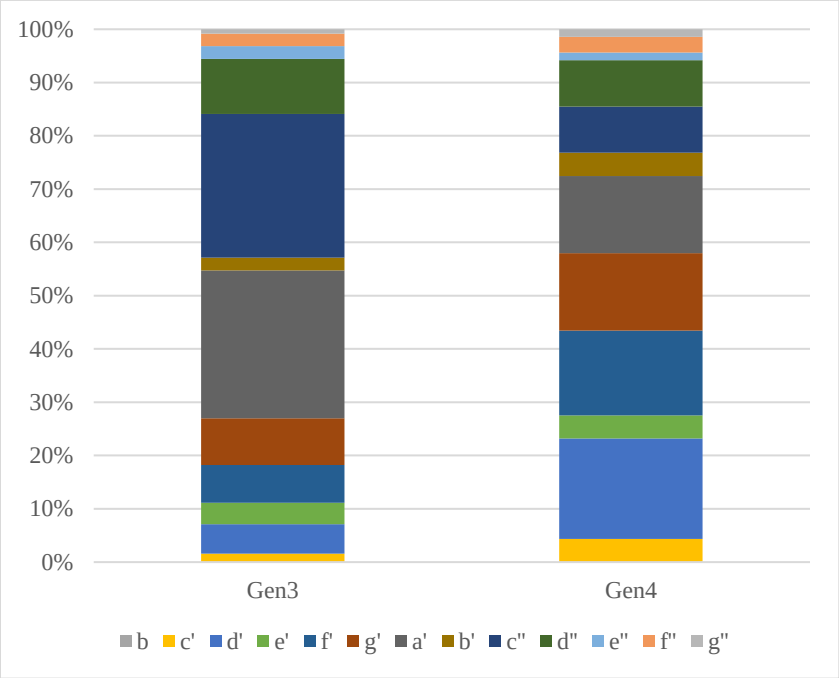


Figure 3.12: First pitches in third and fourth generations

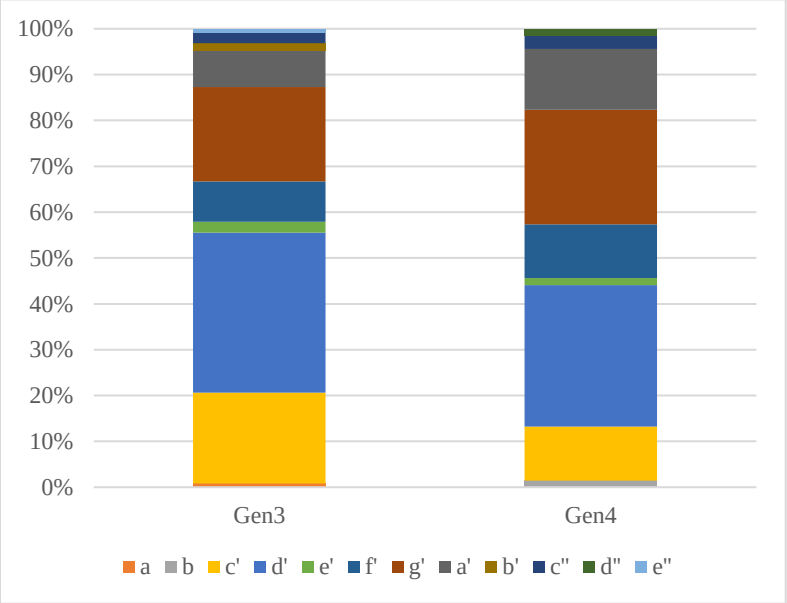


Figure 3.13: Last pitches in third and fourth generations

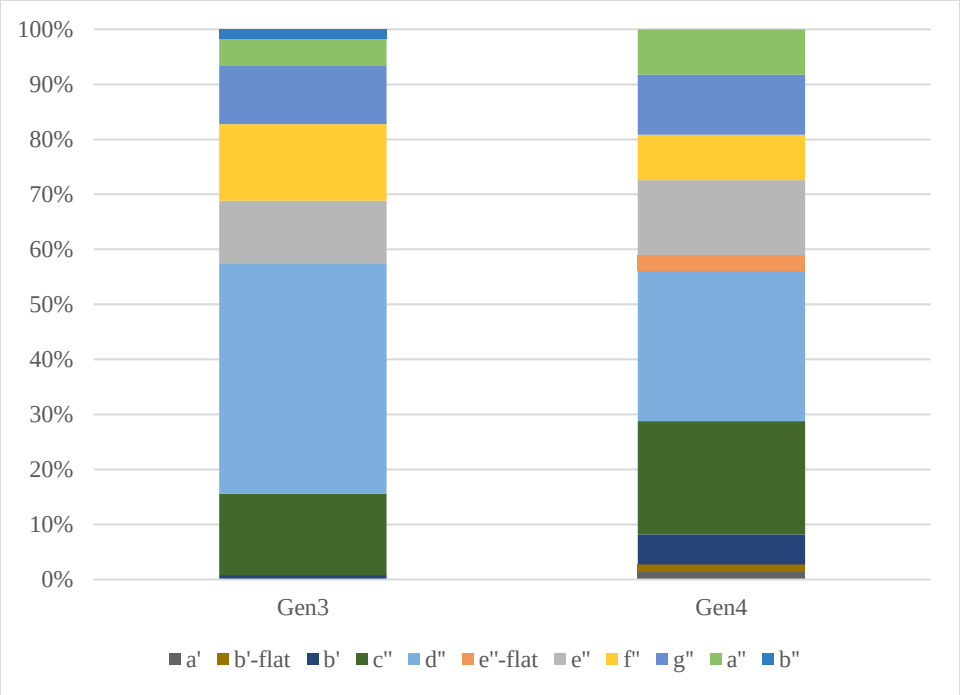


Figure 3.14: Highest pitches in third and fourth generations

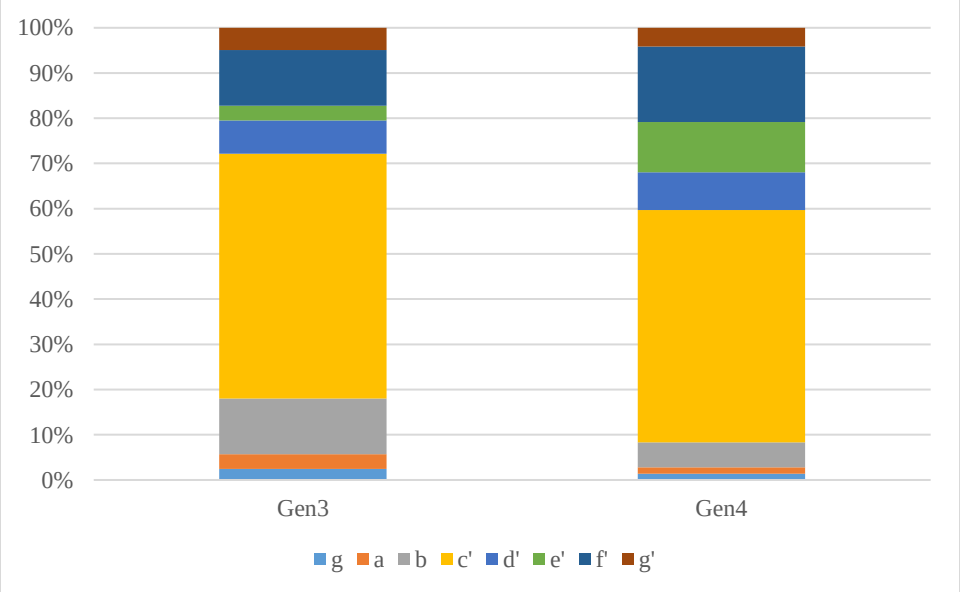


Figure 3.15: Lowest notes in third and fourth generations

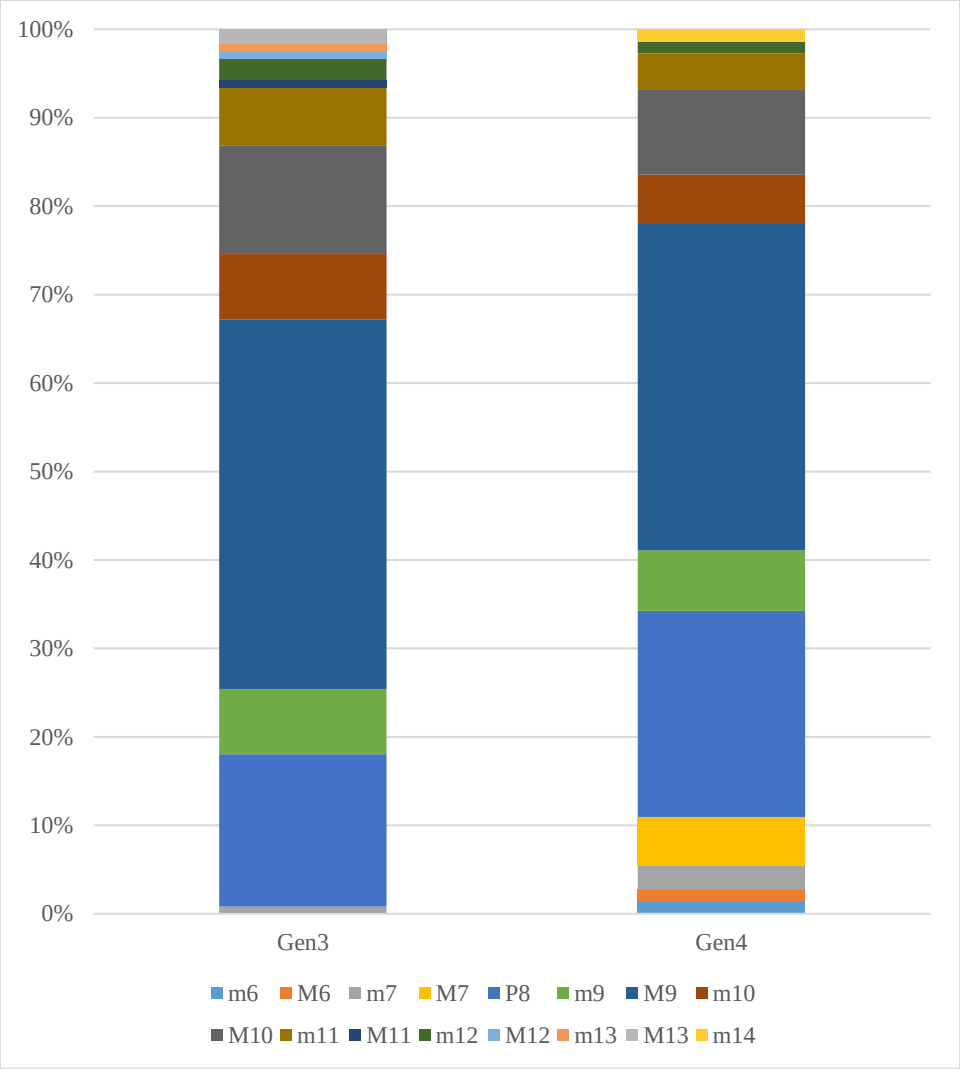


Figure 3.16: Range intervals in third and fourth generation melodies

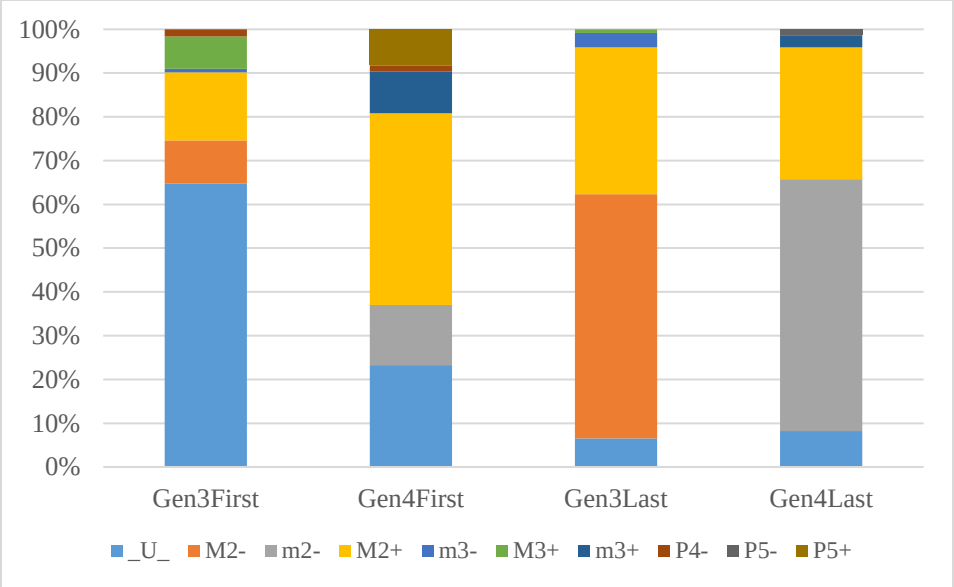


Figure 3.17: First and last intervals in third and fourth generations

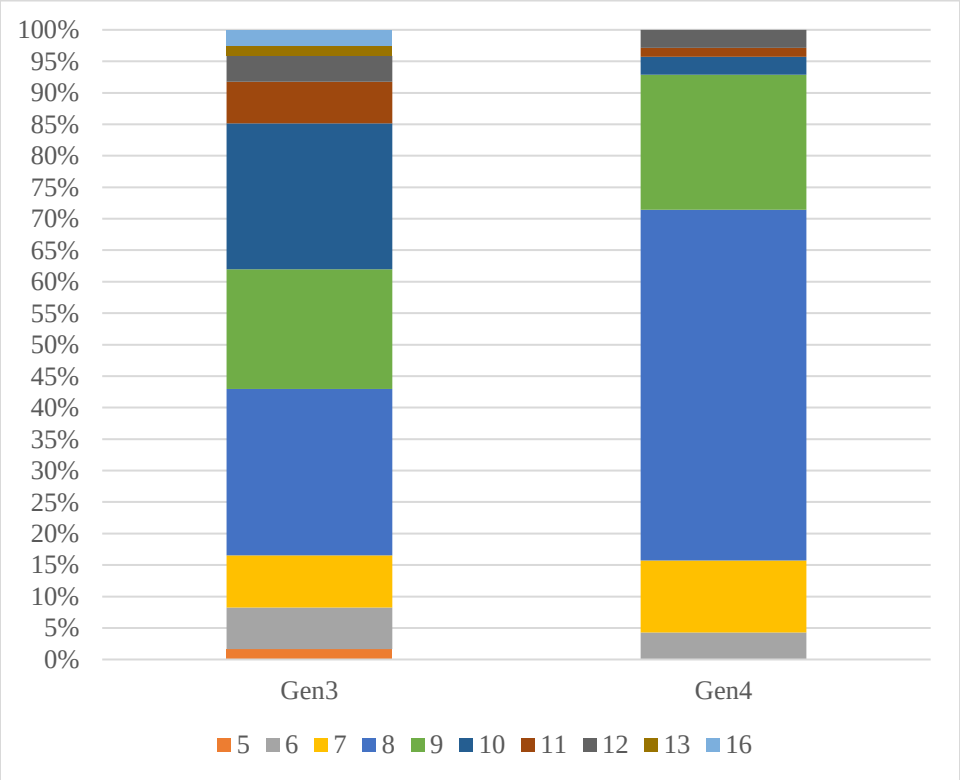


Figure 3.18: Melody length by phrase for third and fourth generations

Visualizations for Comparison of Musical Characteristics by Period

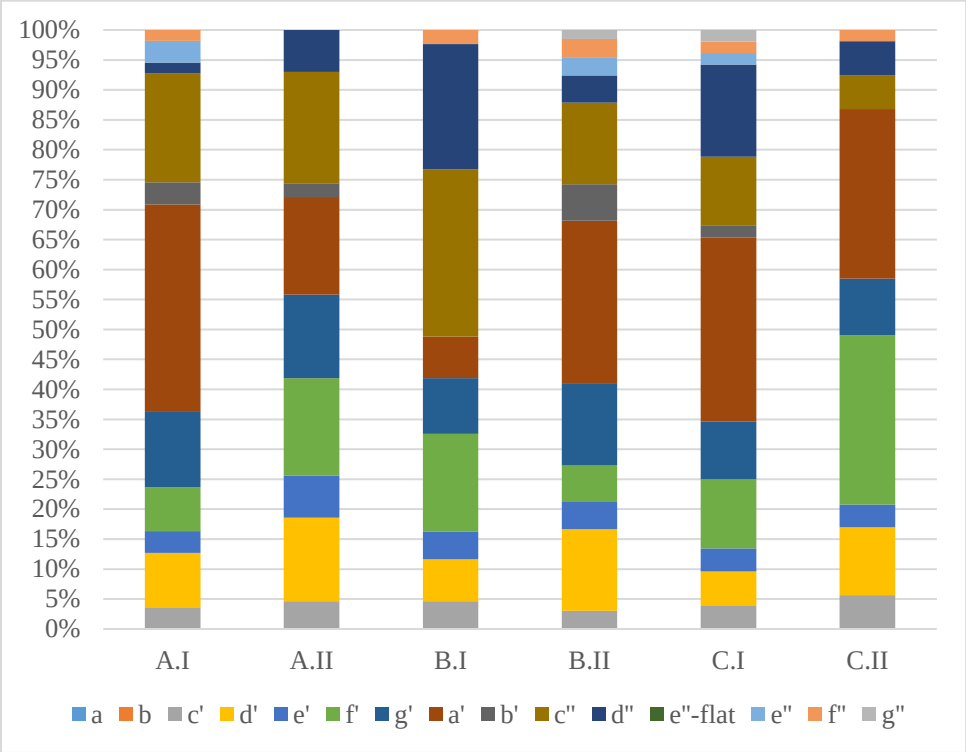


Figure 3.19: First notes by period

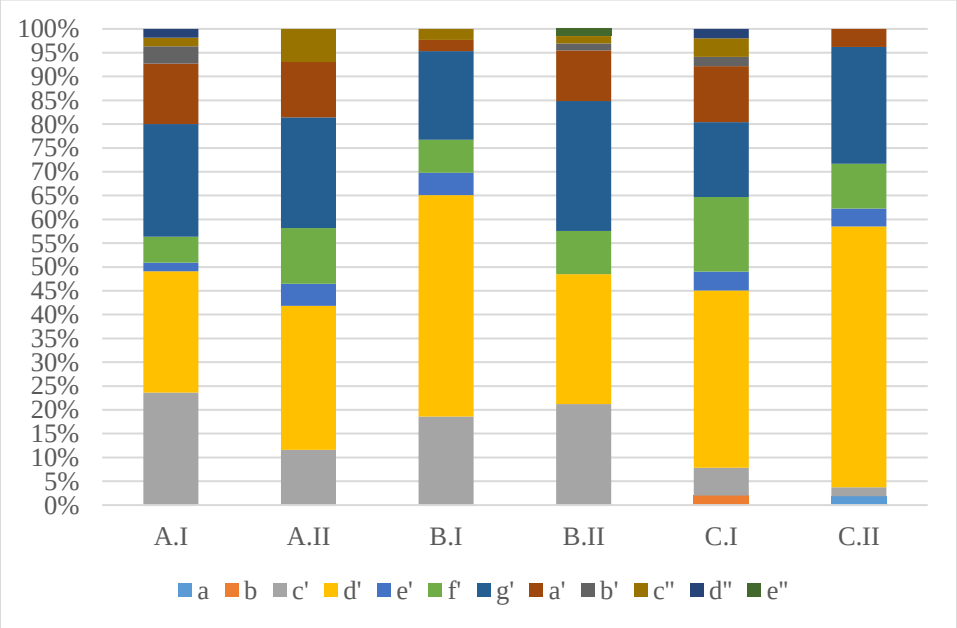


Figure 3.20: Final notes by period

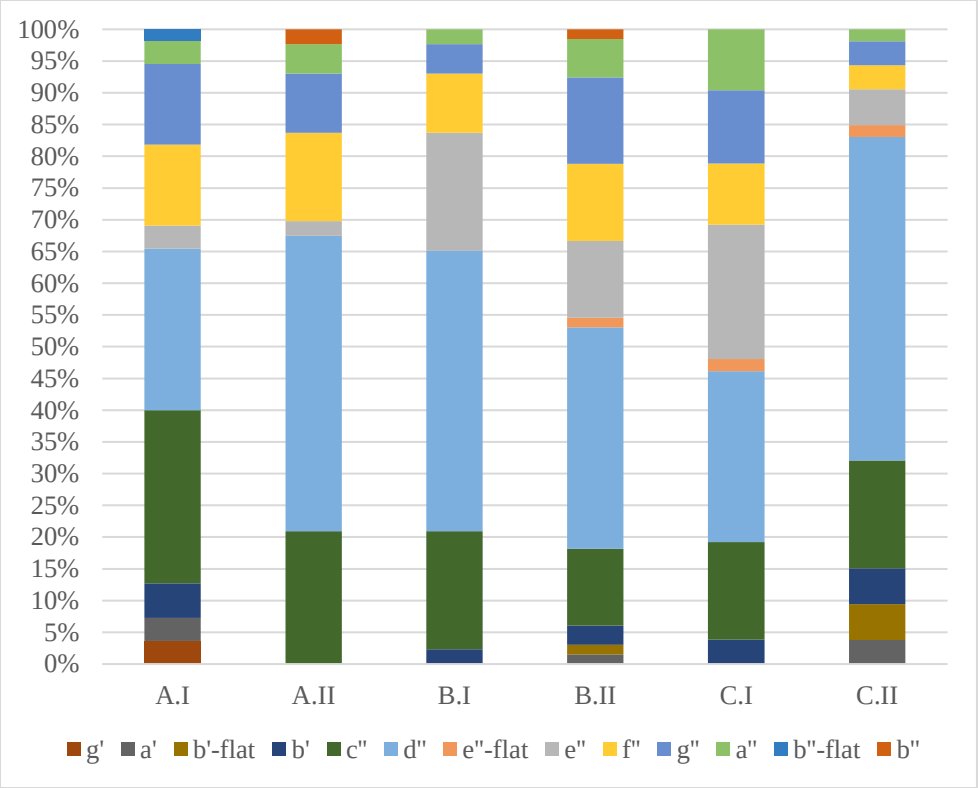


Figure 3.21: Highest notes by period

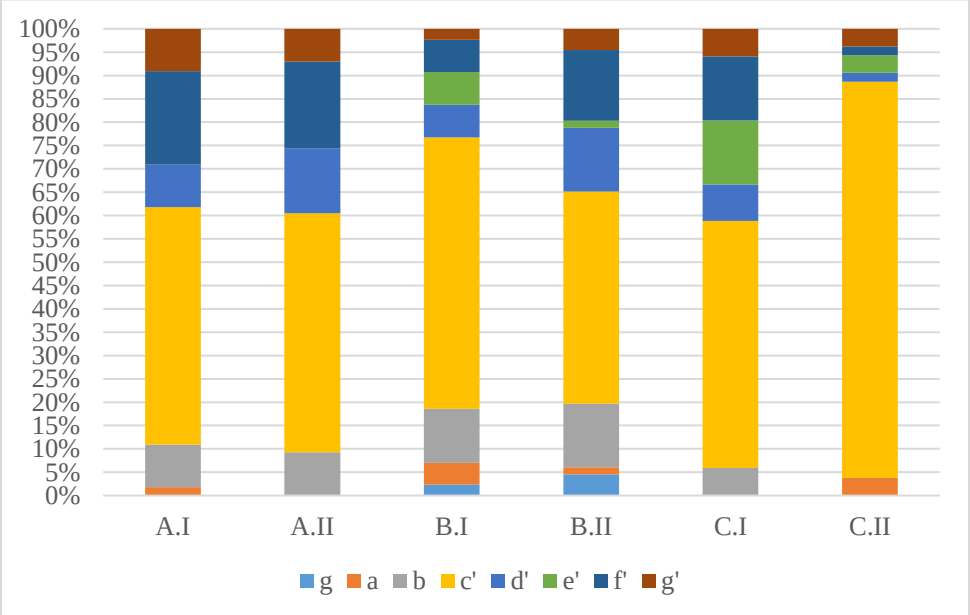


Figure 3.22: Lowest notes by period

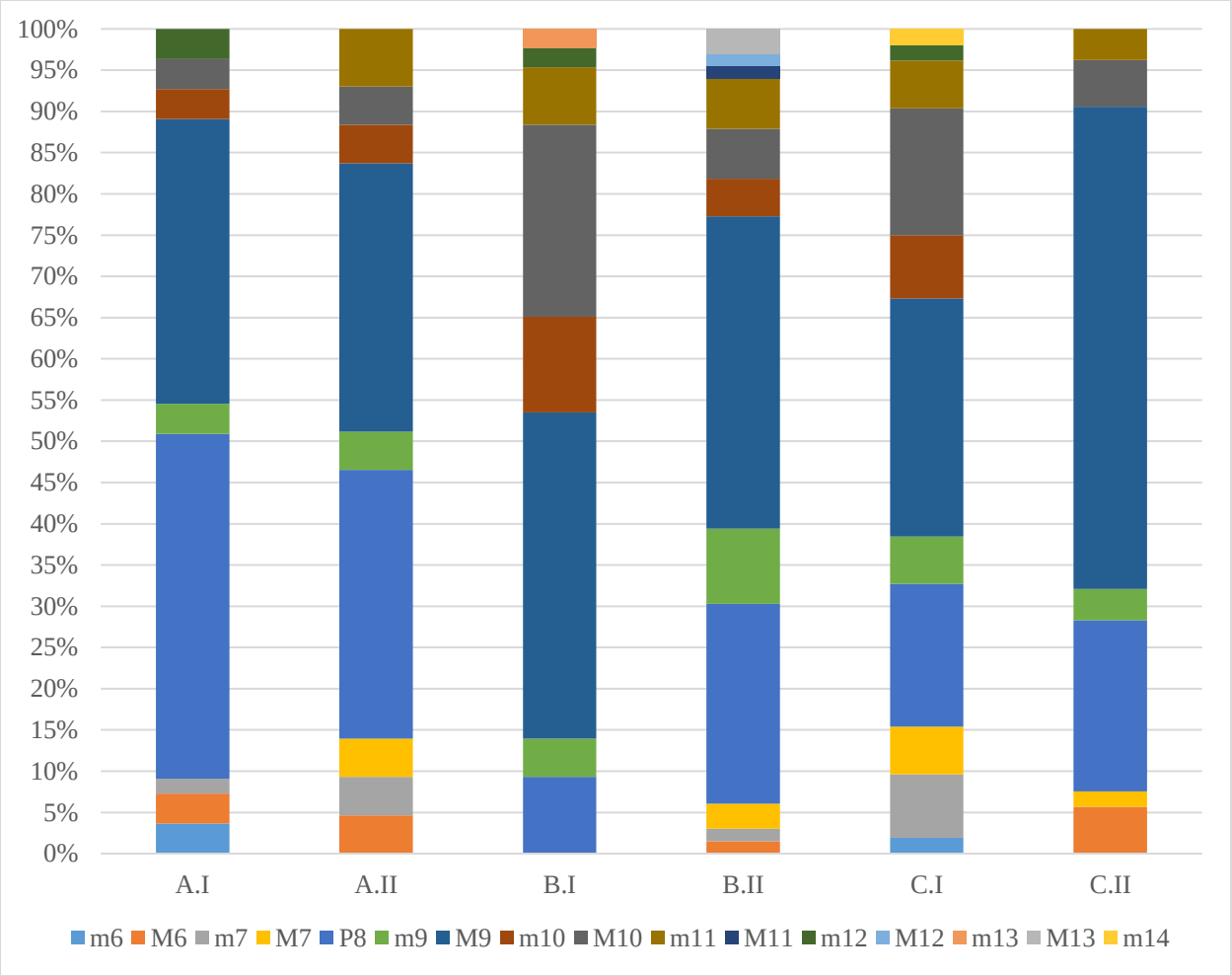


Figure 3.23: Range intervals by period

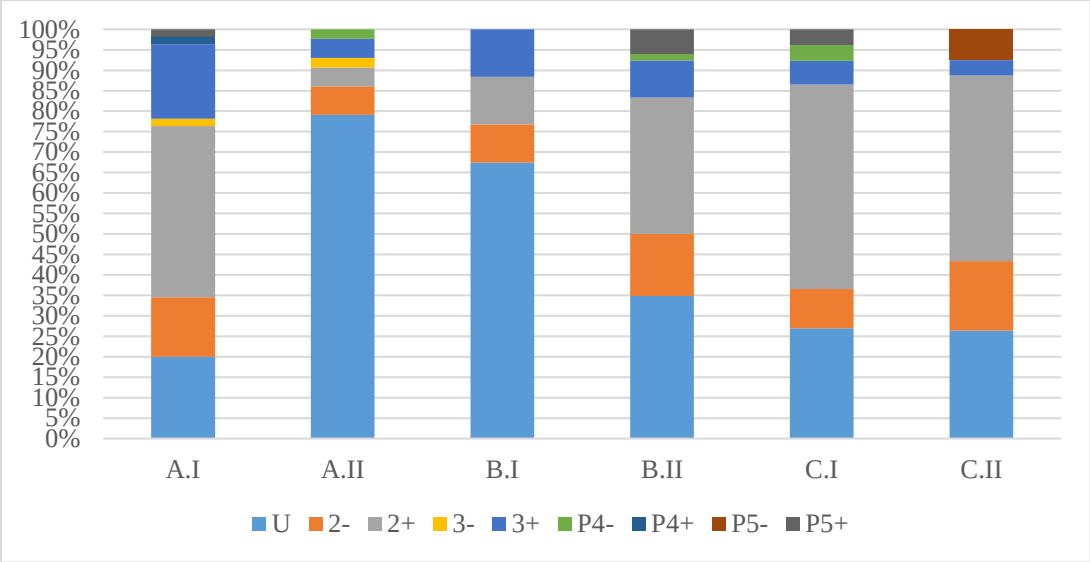


Figure 3.24: First intervals by period

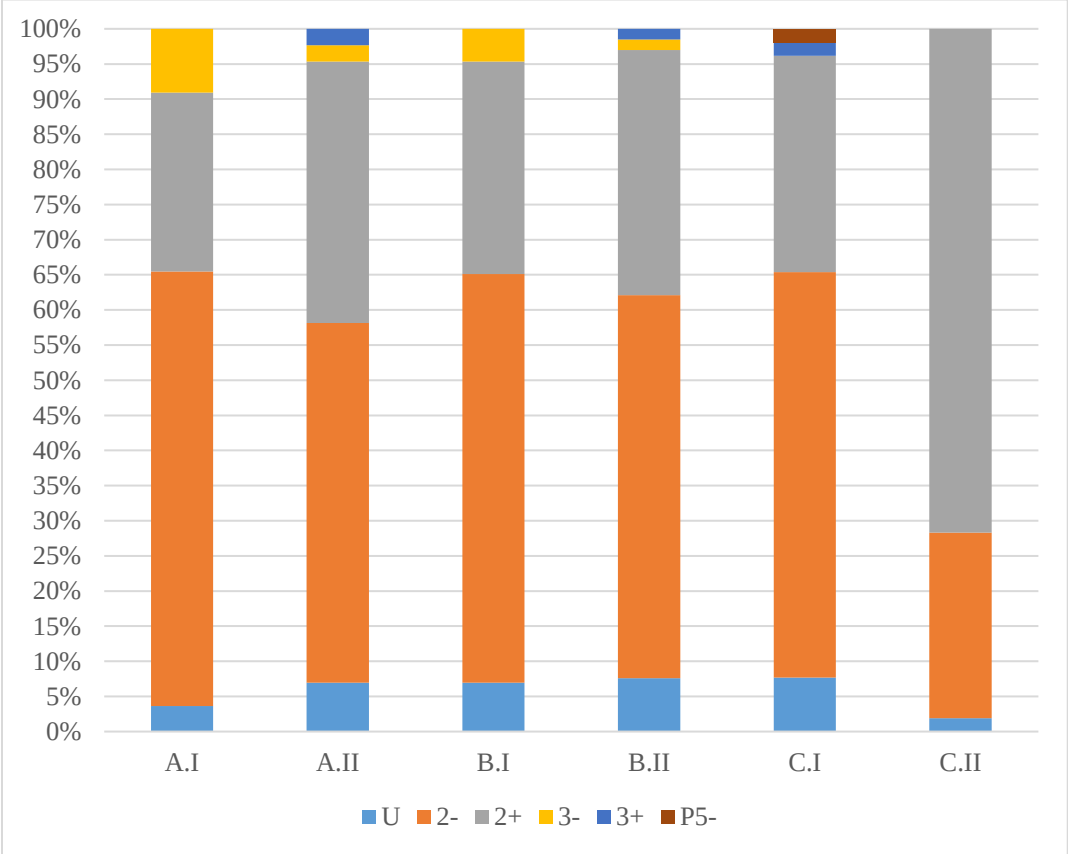


Figure 3.25: Last intervals by period

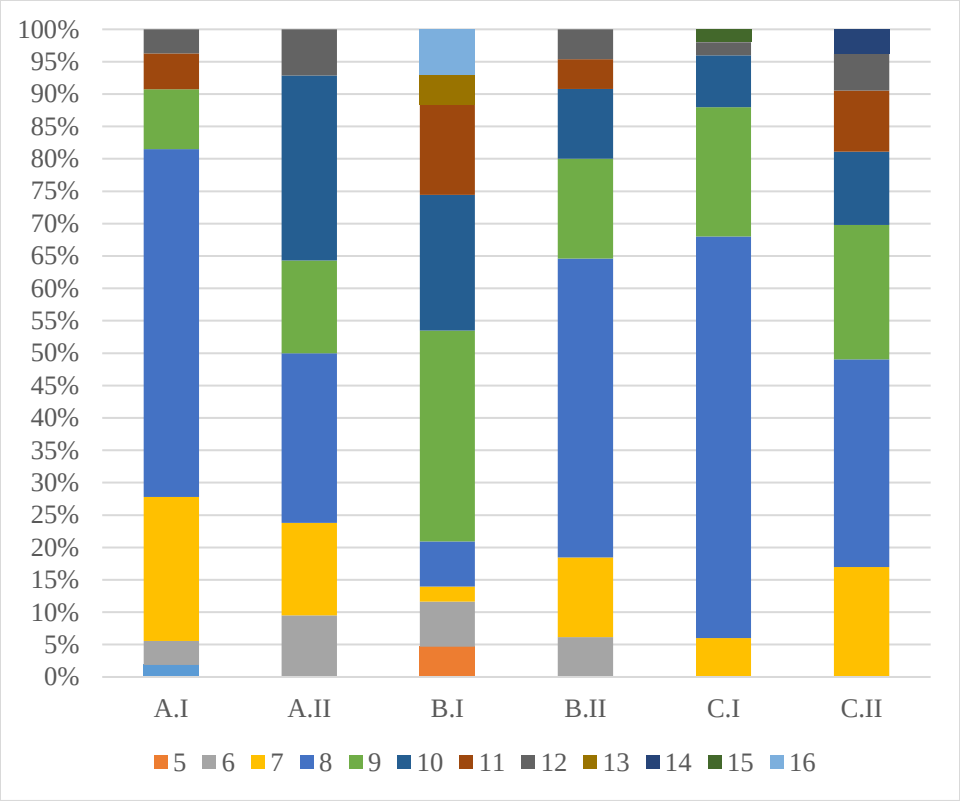


Figure 3.26: Number of phrases by period

Case Study 2: Modality and Troubadour Song

Through computational musicology, we can more easily analyze the pitch organization within melodies. Scholars disagree on the extent to which the church modes are applicable to the troubadour melodies (both in terms of practice as well as theory); while many of the songs can be adequately described through the church modes, neither modern analysts nor a contemporary of the later troubadours, Johannes de Grocheio (c.1255-c.1320), consider them to have been consistently implemented in the repertory.[228] The two repertories do have connections: they are contemporaneous traditions; all of the neumatic notations used to notate troubadour song are also used to notate chant; they share some similarities in musical characteristics (discussed in more detail below); there is evidence of sacred song in Occitan and sacred subjects appear in some troubadour songs; and there are identified cases of contrafacture between sacred works and troubadour song, such as those found in *Chig* or the Latin contrafact of Bernart de Ventadorn's "Quan vei la flor" (BEdT 70,042) attributed to Philip the Chancellor.[229] The characteristics that define the church modes (final, ambitus, and reciting tone) are, as noted by Theodore Karp, often thwarted in troubadour song through the use of larger ranges, the position of final pitches with respect to the overall range, the appearance of multiple pitch centers, and final pitches outside

[228] Aubrey, *Music of the Troubadours*, 136. For a translation of the relevant part of Grocheio's *De Musica*, see Page, "Johannes de Grocheio on secular music: a corrected text and a new translation." Also see Claudio Vanin's discussion of Grocheio with respect specifically to troubadour song. Vanin, "Musical form," 181-184.
[229] Collations of the contrafacts in *Chig*, including that for the song by Bernart, appear in Van der Werf's edition. The relationship between troubadour song and liturgical song is discussed by scholars of both the text and music, including William Paden, "What Singing Does to Words: Reflections on the Art of the Troubadours," *Exemplaria* 17, no. 2 (2005): 499-500; Catherine Léglu in her monograph *Between Sequence and Sirventes, Aspects of Parody in the Troubadour Lyric* (Oxford: European Humanities Research Centre, 2000); and Margaret Switten in *Cansos of Raimon de Miraval*, 17-20, and "Modele et variations: Saint-Martial de Limoges et les troubadours," in *IIIe Congrès international de l'Association international d'études occitanes, Montpellier, 20-26 settembre 1990: Contacts de langues, de civilisations et intertextualitié*, 2 vols. (Montpellier: Centre d'etudes occitanes, 1992), 2: 679-96.

those allowed by the church modes.[230] Identifying songs by transposed modes can be useful in some cases, but overall, the church modes cannot be consistently located within troubadour melodies.[231]

Alternatively, some songs are described as having multiple pitch centers, rather than one; in other cases, scholars like Curt Sachs, Ian Parker, and Claudio Vanin have also analyzed melodies' structural organization as a chain of thirds.[232] Hendrik Van der Werf chose to use vocabulary that did not overlap with that used for church modes (particularly 'final') to avoid the implication that the melodies should all be catalogued by one of the church modes.[233] He preferred to describe the melodies' internal organization with respect to a major and a minor medieval scale rather than to assign the songs rigorously to church modes, in transposition or otherwise.[234] Ian Parker's dissertation and subsequent article also address the issue of modal analysis in troubadour song, noting the limitations of its application to troubadour song overall while presenting a subset of the melodies and their adherence to modal structures and organizations which point towards interval chains (primarily of thirds).[235] Margaret Switten chose to organize melodies by Raimon de Miraval by their final pitch in her study of his *cansos*, noting "I am well aware of the deficiencies of this procedure, but have found it nevertheless

[230] Karp, "Troubadours, Trouvères: Modality," Grove Online. For an overview of how modes are structured, see Leo Treitler, "Troubadours Singing Their Poems," 21-23.
[231] See discussions of this in Switten, *Cansos of Raimon de Miraval*, 17; Karp, "Troubadours, Trouvères: Modality"; Van der Werf, *Extant Melodies*, 31-32; and Van der Werf, *The Chansons*, 46-59. Switten discusses Miraval's melodies by final pitch, noting their ranges and other features which are (or are not) indicative of a modal pitch organization.
[232] Van der Werf, *The Chansons*, 50, 52; Parker, "Form and Melodic Structure," 296-300; Vanin, "Musical form," 187-190. Leo Treitler provides an analysis of selected troubadour melodies in "The Troubadours Singing Their Poems," 23-29.
[233] Van der Werf, *Extant*, 31-32.
[234] Van der Werf, *The Chansons*, 55-56.
[235] Ian Parker, "Troubadour and Trouvère Song," and his dissertation, "Form and Melodic Structure," particularly Chapter 4.

expedient for my purposes."[236] Claudio Vanin's 1994 dissertation examines the applicability of both modes and chains of thirds to the troubadour repertory, drawing on a selected subset of the melodies for his analysis.[237] He concludes that both approaches have merit for many songs in his study, and points to a functional role of the final pitch for melodies that have an established tonal center. Aubrey's study notes the difficulty of establishing a consistent role of a final pitch and the prevalence of melodies which have more than one pitch center.[238]

Here, I investigate the extent to which troubadour song conforms to the modal systems of pitch organization found in chant using computational approaches. This approach departs from previous studies in its consideration of the entire repertory, rather than a subset, and through its inclusion of a broader range of musical features. I assess the presence of defining features of the church modes in the melodies based on features extracted from the encoded melodies by the Melody Analysis Tool (see discussion of this tool in Chapter I) that may function as structurally important pitches either because of their location or through their emphasis by frequency or reiteration. These include the final pitch, the range of the entire melody, the range of the melody above the final pitch, the range of the melody below the final pitch, the most frequently appearing pitches, the inclusion of accidentals in the original source, first pitches, and internal cadences.[239] The use of reiterated pitches in a style similar to that of the reciting tone in chant will also be considered here. From these, I determine which melodies exhibit features reflective of the church modes.

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[236] Switten, *Cansos of Raimon de Miraval*, 17. She gives an overview of perspectives on modality in troubadour song as well in pages 17-20, focused particularly on modal features in Miraval's melodies.
[237] See Vanin, "Musical form." There are some differences in range for a small number of melodies used in his study compared to the transcriptions in both the TMD and in Van der Werf's edition.
[238] Aubrey, *Music of the Troubadours*, 174-176.
[239] Accidentals for troubadour song, as discussed in Chapter I, are primarily found as B-flats in the sources, with a smaller number of appearances of E-flat. 129 troubadour songs include at least one notated flat; seven of those have a flat written at the beginning of each staff as a signature.

Description of Modal Features

First, I will outline the different parameters used to determine a melody's mode with respect to the makeup of the repertory overall. The first of these is the last pitch of the melody, designated 'the final' during modal analysis. For troubadour song, almost forty percent of the extant melodies end on D; G is the second most common, appearing as the final pitch in twenty-four percent of melodies.[240] The number of melodies ending on each pitch class appears below as Figure 3.27.

Finals (pitch class)	No. of Melodies
A	31
B	4
C	54
D	125
E	10
E	34
G	81

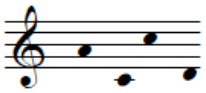
Figure 3.27: Final count by pitch class

The extant troubadour melodies thus use all seven pitch classes as finals, whereas the church modes (theoretically) use only four (D, E, F, and G) in the thirteenth and early-fourteenth centuries. A clear majority of the melodies (seventy-four percent) do use the same finals as the church modes, however. Some finals only appear in one or two sources: the lowest two finals (a and b) appear only in *G*, while the highest (e'') appears only in *R*. Final pitches on E and B, rare in the repertory, only appear in *G* and *R*, while a final pitch of d'' only appears in *W* and *X*.

[240] As discussed in Chapter I, pitch classes appear as capital letters (A, C) and octave-specific pitches are named following the Helmholtz system, with the letter of the pitch with octave indicated through case and the use of apostrophes (a', c'', etc.).

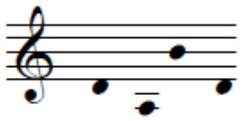
Overall, the distribution of finals between sources lacks strong enough tendencies to be indicative of any preference on the part of the scribe or in the nature of exemplars with respect to final pitches of the melodies.

The range of the melody is used to determine whether it falls in the authentic or plagal category of melodies with that final. This includes both the range overall and the range of the pitches in the melody that are above or below the final. I will illustrate these different features by using two melodies as examples with the same final (D) that reflect characteristics of either the authentic mode on D (dorian) or the plagal mode on D (hypodorian). The melody for the Comtessa de Dia's "A chantar" (BEdT 46,002) has an overall range of an octave; the pitches range a minor seventh above and a major second below the final (represented below in the melody's boundary notes, in the order first/lowest/highest/last).



Music Example 3.2: Boundary pitches for "A chantar"

The melody thus contains pitches almost entirely above its final, matching the criteria for a melody with an authentic range (comprising an octave above the final, with the possibility of one additional pitch below the final, designated the subfinal). Raimon de Miraval's "Bel m'es" (BEdT 406,012) instead has a range of a major ninth which spans a perfect fourth below the final and a major sixth above it (see the boundary notes for the melody below).



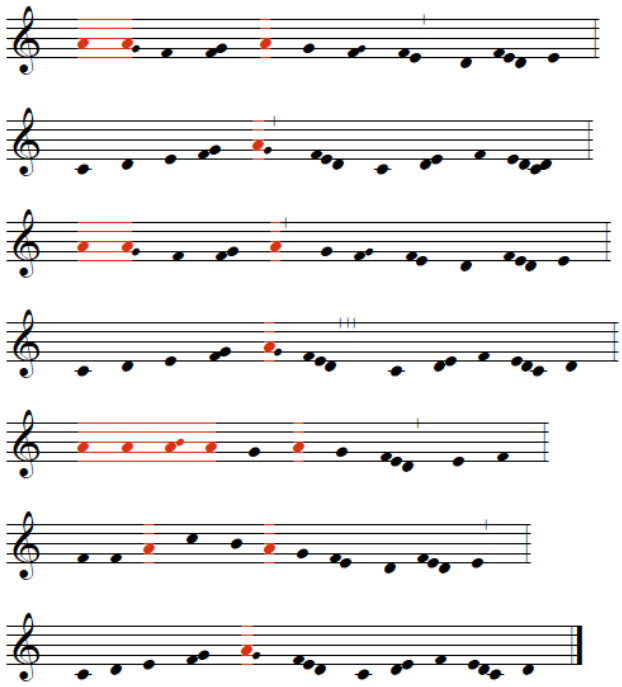
Music Example 3.3: Boundary pitches for "Bel m'es"

Miraval's melody thus fits the plagal range, which typically encompasses an octave beginning a fourth below the final.[241] For the troubadour melodies overall, sixty-two percent (two-hundred-and-ten) of the melodies have ranges that would be considered authentic, with a range beginning on the final or the subfinal. However, many of the melodies (eighty, or twenty-five percent) exceed the typical range of an octave or ninth found in the church modes. Ranges for troubadour melodies include all intervals between a sixth and a fourteenth (excluding fragments too short to accurately assess the range).[242] Ranges of a twelfth or higher are rare; only two melodies have a range of a fourteenth, the versions of Peire Vidal's "Be·m pac d'iverns e d'estiu" (BEdT 364,011) preserved in *X* and *G*.[243]

In chant, the reciting tone (the reiterated pitch on which psalm verses are recited) is an important structural pitch that is emphasized both through frequency of appearance and through repetition. For authentic mode melodies, the reciting tone is typically the fifth above the final, and for plagal modes it is typically the third above the final (with some alterations when the reciting tone would fall on B). This is not consistently the case in troubadour song, where reiterated pitches appear in eighty-seven melodies but not necessarily on the pitch that would

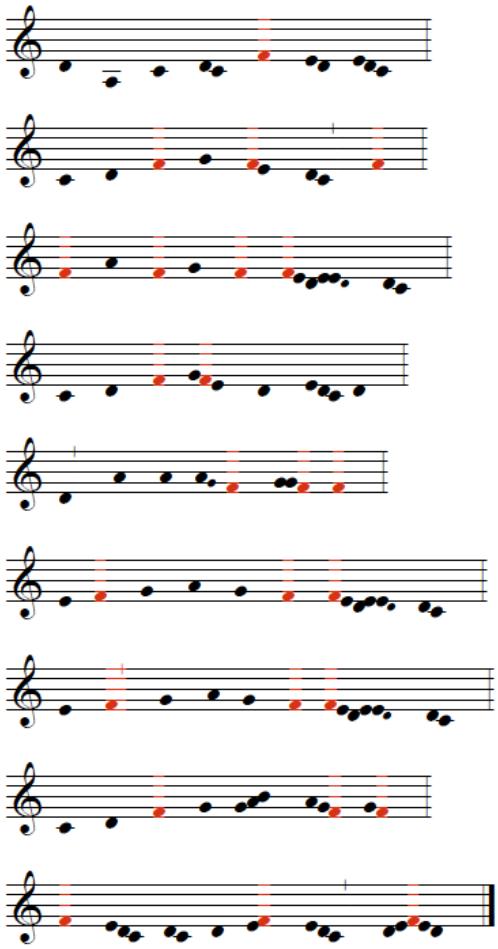
[241] Switten notes that this is the only melody extant by Miraval which uses the plagal range. Switten, *Cansos of Raimon de Miraval*, 18.
[242] The edition concordance in Appendix B identifies which of the melodies are fragments excluded from this analysis.
[243] The melody for the same text in *R* has a range of a ninth.

serve as the reciting tone of a chant with the same final and range. For "A chantar," the most frequently appearing pitches are f', e', and d'. The fifth above the final (d'), a' (marked with red in Music Example 3.4 below), is the fifth-most frequent pitch in the song; however, in the fifth phrase it is treated similarly to a reciting tone, in the first and third phrases, which are identical.



Music Example 3.4: "A chantar" with a' marked in red

"Bel m'es," with a plagal range for the same d' final, has d', f', and e' as its most frequent pitches (the same pitches as "A chantar," reordered; see Music Example 3.5).



Music Example 3.5: "Bel m'es" with f' marked in red

The reciting tone for a hypodorian melody, f' (marked in red above), is the second-most often used pitch in the melody, but not as often as a reiterated pitch as a' in "A chantar." This feature of the church modes is fairly inconsistent in the repertory overall. This is perhaps not surprising given the functional difference of repetition of a pitch in chant versus troubadour song. Instead of being used to carry text quickly and clearly throughout a church, repetition in troubadour songs emphasizes the text through its declamatory setting.

Internal cadences can reflect the degree to which a final pitch is a point of melodic focus throughout the melody. The interval cadences for "A chantar" are, in order: e/d/e/d/f/e/d; the

internal cadences thus place emphasis on the final and the two pitches above it. [244] All of the internal cadences are a second apart except between phrases four and five, which are a third apart. The internal cadences for "Bel m'es" are quite different from those found in "A chantar," with cadences on these pitches, in order: c/f/c/d/f/c/c/f/d.[245] This melody thus emphasizes the subfinal and the third above the final (the reciting tone of hypodorian), with the internal cadences from a unison to a fourth apart. The relationship between the ends of musical phrases and the beginning of the subsequent phrase is also a feature to consider for pitch organization, discussed further below in connection with the role of first pitches in melodies.

Initial pitches also factor into the pitch center (or pitch centers) of a melody. While not necessarily reflecting the intonation patterns found more or less consistently in chant, the first notes of troubadour song should be considered in determining which notes are emphasized in a melody.[246] For "A chantar," three of seven phrases begin with a', three on c' (one pitch below the final), and one on f': a'/c'/a'/c'/a'/f'/c'. "Bel m'es" has two phrases which begin on d', three on the subfinal c', two on f', and two on e': d'/c'/f'/c'/d'/e'/e'/c'/f'. It also has a consistent relationship between the final notes of phrases and the first note of the next; in all but two cases, each phrase begins on the same note that ended the previous phrase. Since the melody begins on the same pitch as the final (d'), the same pitch relationship exists between the end of one stanza and the beginning of the next. This pattern also holds for the singing of the *tornada* (the final, shortened, stanza of the poem), which would be sung beginning with the fifth musical phrase (on d').

[244] The melody is in bar form, so phrases 3 and 4 are a direct repetition of phrases 1 and 2.
[245] "Bel m'es" has less internal repetition than "A chantar," with the form ABCDEFFG, although phrases D and G are related to B.
[246] For a discussion of the presence of intonation formulas in chant, see Van der Werf, *The Chansons*, 47-49, and Vanin, "Musical form," 191-192.

The inclusion of altered notes in a melody also factors into the designation of a melody's mode as it alters the series of whole and half steps found within the melody. 125 melodies in the troubadour corpus have one or more notated accidentals.[247] These are nearly all flat signs creating b'-flat. A small number are e''-flats, with one occurrence of b''-flat. There are also two accidental signs which cannot be encoded within the existing version of Volpiano: one raised f'' and one raised c'' (both appear in melodies from trouvère sources).[248] It is rare for all occurrences of a pitch in a melody to be explicitly altered; it is more common instead for all appearances of a pitch in one phrase to have the same alteration. There are, however, melodic phrases with both altered and unaltered versions of the same pitch.

After conducting analysis on the melodies to gather data on the structural features of church modes, I turned to computations which analyzed methods of pitch emphasis in the melodies themselves. These included determination of the three most frequent pitches in each melody and identifying recitational passages (melodies with reiterated pitches), which are discussed separately below. The data from these aspects was then used within the context of the larger features of pitch organization in the melodies already discussed, with a focus on the relationships between pitches emphasized through position (first and final pitches) and through frequency of appearance.

With the musical features that define mode established for each melody, I then considered observable patterns in pitch emphasis seen in the melodies, beginning with frequency of appearance. I identified the three most frequently used pitches for each melody and compared them to each other as well as to the first and final pitches of each melody. Figure 3.28 below

[247] See Chapter I for an explanation of how accidentals were treated in the encoding process for the TMD.
[248] These are the melodies for "Ar agues eu mil marcs de fin argen" (BEdT 372,003) in *Cangé* and "Pax! in nomine Domini" (BEdT 293,035) in *W*.

shows each pitch with the number of times it appears as the most frequent, second most frequent, and third most frequent pitch (the pitch with the most appearances in each column is marked in bold).

Pitch	Most Frequent	2nd Most Frequent	3rd Most Frequent
c’	0	1	4
d’	21	25	23
e’	30	42	42
f’	38	34	**92**
g’	81	**97**	51
a’	**109**	64	38
b’	17	34	37
c’’	14	22	33
d’’	22	13	12
e’’	6	9	8
f’’	2	0	1
g’’	1	0	0

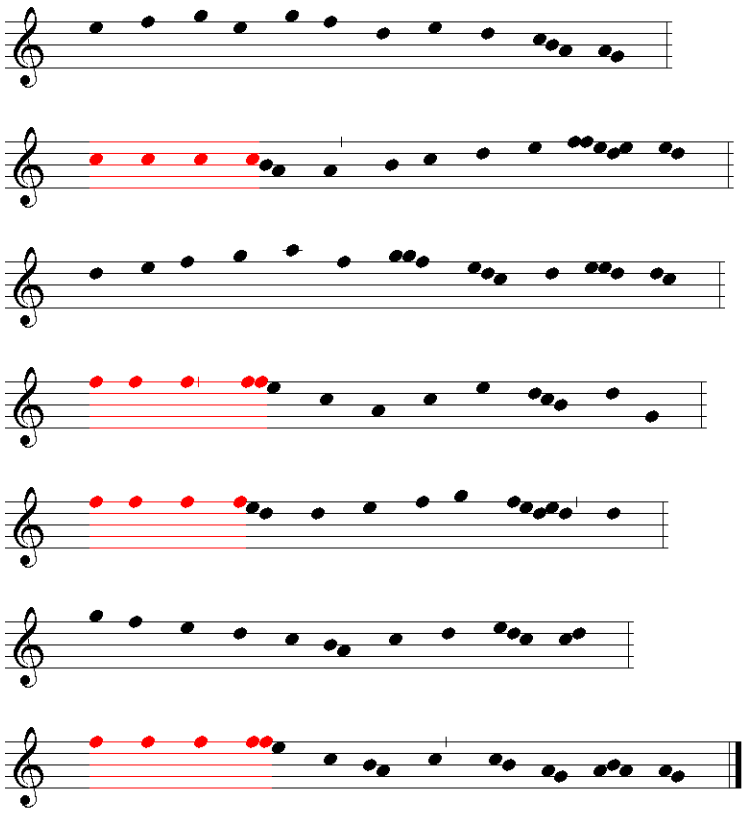
Figure 3.28: Pitch frequency of occurrence

The most commonly used pitches tend to fall within the range of an octave (from d’ to d’’) with a’, g’, and f’ occurring most often overall. In comparisons of these rates of frequencies to the final pitches of the melodies, some trends were evident. Melodies that end on d’ tend to have a’ as the most frequent pitch, as do melodies that end on g’. When a melody ends on c’, g’ is often the most frequent pitch, while melodies that end on a’ tend to also have a’ as the most frequent pitch. Overall, a’ appears most often in the largest number of melodies (a third), followed by g’ (twenty-five percent). Trends in the second most frequent pitch are less clear, but melodies ending on d’ tend to have g’ as the second-most common pitch. The third most common pitch is frequently f’ in melodies ending on c’, d’, f’, and g’. When I compared the first and second most common pitches in each melody, the primary observable tendency is for melodies with a’ as the

most frequent pitch to have g’ as the second-most frequent (and vice versa). There is a more even distribution of pitches which appear most often with particular first pitches than final ones; however, a’ and g’ have the highest rate of appearance as the most frequent pitch for melodies that begin on g’, a’, and c’’.[249]

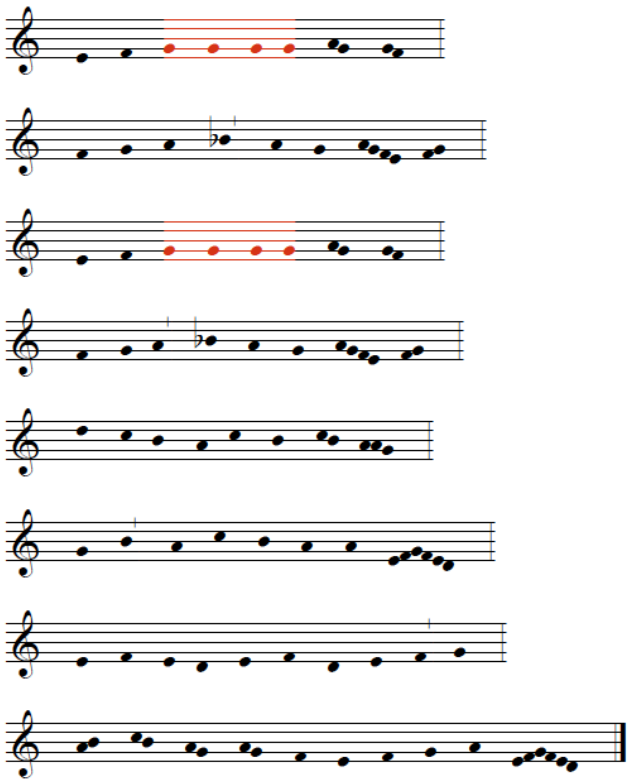
Another measure of pitch emphasis in the melodies is repetition; as mentioned above, recitation does not serve the same function in troubadour song as it does in chant (reciting psalm verses), reiterated pitches that create a similar declamatory text setting are found in many of the surviving songs. Eighty-seven melodies include pitches that are immediately reiterated four or more times.[250] Of these, three melodies have three different reiterated pitches; sixteen melodies have two reiterated pitches (see Music Example 3.6 for an example of the latter, Bernart de Ventadorn’s “Quan vei la flor” (BEdT 70,042) in *X*). “Quan vei la flor” not only has recitational passages on two different pitches (c’’ and f’’), but also emphasizes the recitation through its placement at the beginning of four of its seven phrases.

[249] For the data tables showing these tabulations, see the dissertation resources in the TMD.
[250] Here I consider only pitches that are immediately repeated without intervening notes (including *plicas*).



Music Example 3.6: Reiterated pitches in "Quan vei la flor"(X)

The majority of these melodies' recitational passages are four pitches long (fifty-nine melodies). The melody for Bernart de Ventadorn's "Quan par la flors" (BEdT 70,041) in *R* is one example of a melody with this type of recitation (marked in red in Music Example 3.7 below):



Music Example 3.7: "Quan par la flors" (R) with g' reiterations marked in red

Ten melodies have five of the same pitch in a row and nine melodies have six. Only one melody each has either eight, nine, or ten pitches in immediate succession.[251] Five melodies have both four- and five-note series of pitches, while one has both a six-note series and a seven-note. The pitches which appear as reiterated notes overlap with some of those which most often appear as the final note or most frequently appearing note of melodies. Very few melodies recite on E or B, while a', g', and c'' are among the most frequent (see Figure 3.29).

[251] Bertran de Born, "Rassa tan derts e monte pueia" (BEdT 80,037), has two eight-pitch reiterations. The other two are anonymous *lais*: "Gent me nais" (BEdT 461,124, as found in *W*) has a nine-pitch reiteration, and "Finament" (BEdT 461,122, as found in *W*) has a ten-pitch reiteration. The concordances for the two *lais* also include reiterate notes but are fragmentary, so were not considered here.

Pitch	Appearances
c’	1
d’	2
e’	7
f’	9
g’	19
a’	34
b’-flat	3
b’	1
c’’	19
d’’	3
e’’	2
f’’	3
g’’	3

Figure 3.29: Occurrences of reiterated notes by pitch (four or more successive appearances)

The most frequently appearing final pitch (d’), as well as the third most (c’), rarely appear as reiterated pitches. The second (g’), fourth (f’), and fifth (a’) most frequent final pitches are the notes most-often used for reiteration. In the fourteen melodies that reiterate more than one pitch, the interval between the two reiterated pitches is most often a fourth (six melodies), followed by a third (three melodies), a second (three melodies), and a fifth (two melodies). For about half of the melodies with reiterated notes, the note that is repeated is also the most often used pitch in the entire melody. A quarter of the melodies have a reiterated pitch that is either a second or a third way from the most used pitch. The interval relationships between a reiterated pitch or pitches and the final pitch of the melody are summarized in Figure 3.30. The most frequent interval between a repeated pitch and the final is a fourth, followed by thirds and fifths:

Interval	Count
Unison	1
2nd	16
3rd	15
4th	26
5th	14
6th	1
7th	3
8ve	3

Figure 3.30: Interval relationships between reiterated and final pitches

There is not a clear connection between how often a particular final pitch has a reiterated note a particular interval away from it, showing a lack of consistency in this type of pitch relationship compared to the expected interval relationship between finals and reciting tones in the church modes.

In addition to looking at overall trends in musical features of the melodies related to pitch organization, I also analyzed the rate of appearance of different features in the melodies attributed to specific troubadours. For many troubadours, too few melodies have survived to detect trends within a specific troubadour's output. Among those with enough melodies to analyze for patterns in the first and final pitches, most frequent pitch, and range, some troubadours do have an observable trend in their use of a particular note or range. Here, I limit my comments to troubadours with a pitch or range in their extant melodies which has a significant frequency of use.

For final pitches, twelve troubadours' melodies tend to end on a particular pitch compared to others. Some of these tendencies are immediately discernable, like the twenty of thirty-one melodies by Gaucelm Faidit which end on d', while others have two or more pitches

with a similar rate of appearance. The troubadours and the number of melodies with each final pitch appear in Figure 3.31 below (the highest value is marked in bold for each troubadour).

Troubadour	**No. of Melodies**	**Final Pitches**									
		b	**c'**	**d'**	**e'**	**f'**	**g'**	**a'**	**b'**	**c''**	**d''**
Aimeric de Pegulhan	8	1		**3**	1	1	1	1			
Bernart de Ventadorn	33		3	**10**	2	4	9	1		2	
Folquet de Marseilla	27		5	**12**	1	2	5	1			
Gaucelm Faidit	31		3	**20**	1	1	6				
Guiraut de Borneill	4			**3**			1				
Guiraut Riquier	48			**28**	2	4	12	1			
Jaufre Rudel de Blaja	6		**4**			1	1				
Peire Vidal	18		**8**	1	1	3	4	1			
Peirol	19		5	**6**			5	3			
Raimbaut de Vaqueiras	8		1	2		1	**3**		1		
Raimon de Miraval	26		2	7		5	**8**	2		2	
Richart de Berbezill	7		3			1	2				1

Figure 3.31: Troubadours with trends in final pitches

In addition to Gaucelm, two other troubadours' melodies have a tendency towards a particular final pitch: Guiraut Riquier (twenty-eight of forty-eight melodies end on d') and Folquet de Marseilla (twelve of twenty-seven melodies end on d'). In the cases of troubadours with a smaller output, I included those that have a majority of their melodies ending on a particularly pitch, such as Guiraut de Borneill, who has three of four melodies ending on d'. For troubadours with a more even distribution of final pitches, like Bernart de Ventadorn, two or more pitches are used at similar rates; for example, Bernart has ten melodies that end on d' and nine that end on g'. The pitch found most frequently as a significant final is d', which appears as the final pitch most often the melodies of seven troubadours.

Initial pitch appearances are more evenly distributed than final pitches. Ten troubadours appear in Figure 3.27 with the counts of their first pitches. One interesting inclusion here is Peire Cardenal, who has three extant melodies attributed to him which have all been identified as contrafacts; despite this, the three melodies are very similar to each other.[252]

Troubadour	**No. of**	**First Pitches**											
	Melodies	**c'**	**d'**	**e'**	**f'**	**g'**	**a'**	**b'**	**c''**	**d''**	**e''**	**f''**	**g''**
Bernart de Ventadorn	33	3	5	3	**6**	**6**	3	2	3	1	1		
Folquet de Marseilla	27		1	1	2	2	**14**		6				
Gaucelm Faidit	31		3			1	7		**11**	8		1	
Guiraut Riquier	48	4	3	2	13	5	**15**		2	3		1	
Peire Cardenal	3						**3**						
Peire Vidal	18	1	1	2	**4**	1	2		**4**	1	1		1
Peirol	19	2	**5**	1	2	3	3	2	1				
Pons de Capdoill	5								**3**	1		1	
Raimbaut de Vaqueiras	8			1	1	**3**	1	1	1				
Raimon de Miraval	26	1	5	2	**6**	2	4	1	1	2	1		1

Figure 3.32: Troubadours with trends in first pitches

As was the case for final pitches, Folquet, Gaucelm, and Guiraut have the clearest tendencies to use a particular first pitches. The others are less distinct, with a wider range of finals represented; Bernart's melodies begin on f' and g' equally often, while Peire Vidal has an equal number of appearances for f' and c''.

Twelve troubadours have a most frequent pitch which appears in a majority or a significant number of their melodies. Bernart, Folquet, Guiraut, and Peirol have the most noticeable trend towards a particular pitch, while Gaucelm, Peire Vidal, and Raimon de Miraval have a more even distribution of pitch classes that appear most frequently in their melodies.

[252] They also share the same or almost the same boundary pitches and ranges.

Troubadour	No. of Melodies	Most Frequently Used Pitch									
		d’	e’	f’	g’	a’	b’	c’’	d’’	e’’	f’’
Aimeric de Pegulhan	8			1	**3**	**3**	1				
Berenguier de Palazol	8			1	1	1	1		**3**	1	
Bernart de Ventadorn	33	3	2	4	7	**11**	1	1	2	1	1
Folquet de Marseilla	27	2	5	1	**11**	6			2		
Gaucelm Faidit	31	2	3	8	7	**9**		2			
Guiraut Riquier	48	4	7	4	10	**21**	1		1		
Jaufre Rudel de Blaja	6	3				2	1				
Peire Vidal	18		2		**8**	6	1	1			
Peirol	19	3	3		3	**7**	3				
Raimbaut de Vaqueiras	8			1	1	**4**	1	1			
Raimon de Miraval	26	1	2	5	4	**6**	3	1	4		

Figure 3.33: Troubadours with trends in most frequent pitches

The ranges of melodies show some of the most significant tendencies of the musical features considered here. Of twelve troubadours in Figure 3.34, nearly all of them have melodic outputs that emphasize a particular pitch most often. The most heavily-weighted of these are melodies attributed to Bernart, Folquet, and Riquier.

Troubadour	No. of Melodies	Range Interval								
		6th	7th	8ve	9th	10th	11th	12th	13th	14th
Arnaut de Maroill	6			1	**4**			1		
Berenguier de Palazol	8			2	**4**	1	1			
Bernart de Ventadorn	33	4	4	**18**	7					
Folquet de Marseilla	27			5	**18**	2	1	1		
Gaucelm Faidit	31			2	**16**	6	4	2	1	
Guiraut Riquier	48	3	1	10	**30**	3	1			
Peire Cardenal	3				**3**					
Peire Vidal	18				6	**10**			2	
Peirol	19	1	3	**9**	6					
Raimbaut de Vaqueiras	8			1	**5**		2			
Raimon de Miraval	26	1	3	7	**10**	4				1
Richart de Berbezill	7			**4**	2	1				

Figure 3.34: Troubadours with trends in range intervals

The distributions here reflect the prevalence of ranges that are an octave or a ninth in the repertory overall.[253] To examine the characteristics of range in troubadour song more closely, I also looked for trends in interval size for the range above the final pitch (Figure 3.35) and the range below the final pitch (Figure 3.36). The ranges above final pitches in the melodies span from a second to an eleventh, both in the corpus overall and in the melodies by the troubadours considered here. The majority of melodies extend between a fifth and a ninth above their final pitch; Bernart is the only one of the troubadours in the figure below who has the largest number of melodies in his output with a range of a fifth above the final note, with Raimon the only one with the most appearances of a range a sixth above the final pitch. The remaining troubadours all have a significant number of melodies with ranges an octave above the final pitch except for Peire Vidal, who has a significant number of melodies which span a ninth above the final pitch.

Troubadour	**No. of**	**Range Interval Above the Final Pitch**										
	Melodies	**2nd**	**3rd**	**4th**	**Tritone**	**5th**	**6th**	**7th**	**8ve**	**9th**	**10th**	**11th**
Arnaut de Maroill	6			1				1	**3**	1		
Bernart de Ventadorn	33			2	2	**10**	3	8	6	2		
Folquet de Marseilla	27	1				2	4	1	**17**	1	1	
Gaucelm Faidit	31					1	1	2	**18**	6	3	
Guiraut Riquier	48			5	1	6	5	6	**23**	2		
Jaufre Rudel de Blaja	6						1		**3**	2		
Peire Vidal	18						3		5	**6**	2	2
Raimon de Miraval	25		1			3	**7**	4	6	4		
Richart de Berbezill	7			2		1			**3**	1		

Figure 3.35: Troubadours with trends in range intervals above final pitches

[253] Forty-two percent of the extant melodies encoded for this project have a range of a ninth; twenty-four percent have a range of an octave.

Sixteen troubadours have a discernable trend in the range below the final pitch found in their melodies. Many of these troubadours consistently have melodies attributed to them which extend a second below the final pitch (approximately half of the melodies for twelve of these troubadours fit this range).

Troubadour	**No. of Melodies**	**Range Interval Below the Final Pitch**								
		Unison	**2nd**	**3rd**	**4th**	**Tritone**	**5th**	**6th**	**7th**	**8ve**
Aimeric de Pegulhan	8	1	**5**				1	1		
Arnaut de Maroill	6	1	**3**				1	1		
Berenguier de Palazol	8		2	**3**	2				1	
Bernart de Ventadorn	33	5	**15**	3	8	1	1			
Folquet de Marseilla	27	3	**15**	2	3		2	1	1	
Gaucelm Faidit	31	2	**19**	3	3	1	3			
Guiraut de Borneill	4		**3**							1
Guiraut Riquier	48	2	**30**	3	2		9	2		
Jaufre Rudel de Blaja	6	**3**	1	2						
Marcabru	4		**3**				1			
Peire Vidal	18	4	**6**	3	4		1			
Peirol	19	5	**7**				6	1		
Pons de Capdoill	5	1	**4**							
Raimbaut de Vaqueiras	8	2	**3**				2		1	
Raimon de Miraval	25	2	**14**	2	5		2			
Richart de Berbezill	7	**3**	1			1	1	1		

Figure 3.36: Troubadours with trends in range intervals below final pitches

Based on the melodies as notated in the surviving sources, several troubadours exhibit a clear trend in their use of first and final pitches and in the range of the melodies. The temporal distance between the notation of the sources themselves and the period of activity for many of these troubadours raises questions about how accurately these reflect the pitch organization of the song in performance, but for the purpose of this study (and the larger encoding project)

melodies are analyzed based on the notes in the original sources. An exception to this is Guiraut Riquier, who, as discussed previously, likely played a role in the written transmission of his melodies and thus are the most likely to reflect a troubadour's authorial intention. Thus, the pitch tendencies observed here (final pitches on d'; first pitches on a' or f'; most frequent pitch as a' or g'; and melodies with a range of an octave or ninth than most often span an octave above and a second below the final pitch) can be reasonably taken as representative of his compositions.

Evaluation of Evidence for Modal Pitch Organization

Drawing on the features outlined above, some melodies' pitch organization can be sufficiently described by classifying it by one of the church modes, while others lack evidence of modal signifiers. To analyze the extent to which the melodies reflect the different features of pitch organization that define the church modes, I ranked the melodies on seven musical features. These include if the overall range is within a ninth; if the range above and below the final fit that of either authentic or plagal ranges; and if the first and three most frequently used notes are significant with respect to the final pitch in the modal system. Scores for modal features ranged from one to six across the corpus, with thirty-five percent of the melodies scoring a four and thirty-five percent scoring a five. About twelve percent of the melodies scored a six, with eleven percent scoring a three. Less than three percent of melodies scored a two or lower (all the melodies exhibited at least one of these musical features).

I also compared the scores to melodies which have a passage with reiterated notes; despite the similar number of melodies which have four or five modal features, a larger number of those scoring a five have recitational passages (forty-one melodies compared to twenty-eight).

The same number of melodies (nine) have declamatory passages among those which ranked six or three on the mode scale. Ninety percent of the melodies have a range below the final that fits an authentic or plagal range; fifty-six percent have a range above the final that is a ninth or smaller. Around sixty percent of the melodies have a most-frequent pitch or first pitch that is significant with respect to the final pitch in the church modes. The least common musical feature examined here is second-most frequent pitches significant for the melody's final pitch (forty-one percent). When these calculations are joined with the chronological division from Case Study 1, there is a fairly consistent division across the periods by mode score; the exception to this is a higher percentage of melodies which were ranked a six in the final three periods.[254]

Based on the analytical and computational processes used here, several general conclusions may be drawn about pitch organization in troubadour song. Some musical features have clearly defined tendencies, such as the overwhelming majority of melodies which end on d', the predominant use of ranges that begin within a second of the final pitch of the melody, or the prevalence of a' as an emphasized pitch through either reiteration or frequency of appearance. Other aspects of these features demonstrate the variety within musical style of the corpus, which (with respect to pitch organization) lacks a connection between final pitches or the number of mode features of melodies and the source they appear in. Without the same practical need for intonation formulas or reciting tones found in chant, troubadour melodies display a wider range of pitches emphasized through their placement or frequency of use. The modal system from chant was likely influential on pitch organization for troubadours to different degrees as an important part of the soundscape of the period. Further, as discussed previously,

[254] This increase could reflect an increased codification of the church modes during the twelfth and thirteenth centuries in treatises or practice which then influenced secular monophony.

we have evidence of sacred songs in Occitan, sacred subjects in troubadour song, and evidence of borrowing and contrafacture between troubadour song and sacred musical works, and notational similarities to suggest a relationship between chant and troubadour melody (and between composers of liturgical and paraliturgical song and the troubadours). This influence can be seen in the musical features from the modal system which appear in the melodies, and the transmission of melodies which can be classified as a specific church mode. However, there is no consistent application of modal pitch organization in the melodies as they were written, even among those written by the same scribes. Within the subset of troubadours with sufficient melodies for stylistic comparison there are several with clear trends in preferred structural pitches and ranges. Even in the case of songs written into the surviving sources some distance from the period in which that troubadour was active, these trends suggest that the melodies, as transmitted in written or oral forms prior to notation by the scribe, reflected at least some of the tendencies seen in the notated versions.

Case Study 3: Trends in Musical Style across Manuscripts

In Matthew Steel's 1989 dissertation, he conducted quantitative analysis of troubadour songs to compare features such as the rate of appearance of intervals and the average number of pitches per syllable (PPS, which he termed "pitch density.")[255] For his study, he divided the repertory into core and satellite repertoires with 326 and thirty-three melodies, respectively. His analysis aimed, in part, to show differences in the musical characteristics of the repertory as

[255] Steel, "Influences," 48.

found in each manuscript through examination of melodies by six selected troubadours.[256] Since his comparison is based on the characteristics of individual manuscripts, only the major sources are considered here (*G, R W,* and *X),* as the minor sources lack enough melodies from which to draw style generalizations.[257] His approach first divided the repertory into core and satellite groups (largely based on manuscript); he then calculated PPS values for each melody he lists.[258] He also counted the number of intervals larger than a step in his subset of melodies. His computational analysis excluded *plicas,* a decision he notes impacted the outcomes of his computations.[259] I compare the results of my analysis of the subgroup of melodies analyzed by Steel to his results, then expand the same types of analysis to the entire contents of *G, R, W* and *X*.[260] My computational approach permits analysis of the intervallic profiles of the melodies and the average number of pitches per neume (PPN) both with and without *plicas* included in the calculations. While the number of pitches per syllable is typically equivalent to that per neume in the troubadour repertory, there are a small number of cases in which multiple neumes are found over one syllable in the text underlay. The TMD's PPN values thus have a (typically small) deviation from Steel's PPS values because of the differences in our methods. First, I will provide an overview of Steel's approach, then present a comparison of my analysis of Steel's selected

[256] Bernart de Ventadorn, Folquet de Marseilla, Gaucelm Faidit, Jaufre Rudel, Peire Vidal, and Richart de Berbezill. These six troubadours are the only ones with melodies extant in three or more versions in Steel's analyzed corpus since he excludes Matfre Ermengau and Richard "the Lionheart."
[257] The minor musical sources contain one to four melodies each.
[258] Steel's repertory is listed in Appendix A and Appendix B of his dissertation.
[259] Steel, "Influences," 121. *Plicas* are liquescent neumes that typically served a passing function or anticipated the subsequent note. They thus fill in a larger interval (typically a third) while also adding one note to the pitches over a syllable. For discussions of the *plica* in chant and in secular song, see David Hiley, "The Plica and Liquescence," in *Gordon Athol Anderson (1929-1981): In Memoriam von seinen Studenten, Freuden und Kollegen II, Godt-Tischler,* Musicological Studies IXL/2 (Henryville, PA: Institute of Mediaeval Music, 1984), David Hiley, "Plica," Grove Music Online, 2001; Accessed 6 Dec. 2019. https://www-oxfordmusiconline-com.proxyiub.uits.iu.edu/grovemusic/view/10.1093/gmo/9781561592630.001.0001/omo-9781561592630-e-0000021942, and John Haines, "Musicography of the Manuscrit du Roi," 183-196. Haines includes a detailed discussion of *W*'s *plicas* in his dissertation, including their prevalence in particular hands.
[260] See Appendix B for a concordance of melodies by edition and computational studies.

repertory to his work to note how the differences in our methods affect our outcomes. Next, I compare those results to analysis of the repertory overall to note any trends in style among the four main sources.[261] Finally, I utilize the data and analysis gathered for this case study to consider the impact of *plicas* on the text setting style and intervallic content of the songs.

Steel chose the six troubadours who form the basis of his study because they have songs extant in at least three manuscripts; this decision was thus presumably made to facilitate his goal of comparing style across manuscripts.[262] They are listed below with their name, dates, number of melodies extant, and the number of melodies by each included in Steel's study (see Figure 3.37). His primary repertory is limited to the melodies for eighteen songs with concordances in at least three manuscripts attributed to these six troubadours. Steel thus analyzed a total of fifty-five melodies in his computations; in parts of his discussion, he instead relies on all melodies by the six troubadours (108 in total). [263]

Troubadour	**Dates**	**Total No. of Extant Melodies**	**No. of Melodies Analyzed by Steel**
Bernart de Ventadorn	1147-1180	33	12
Folquet de Marseilla	1178-1195	27	9
Gaucelm Faidit	1170-1202	31	19
Jaufre Rudel	1125-1148	6	3
Peire Vidal	1183-1205	18	9
Richart de Berbezill	1140-1163	8	3

Figure 3.37: Troubadours in Steel's computational analysis with counts of their melodies

[261] A comparison of these four main musical sources can also be found in the demonstration of the Melody Analysis Tool at the end of Chapter I.
[262] Steel, "Influences," 98.
[263] Steel, "Influences," 98. He omits Matfre Ermengau, with melodies for one song extant in four manuscripts from this group "because the extreme conformity among versions suggests a literate tradition." Steel, 98. Richard "the Lionheart" also has four melodies for one song extant in sources, "Ia nus hons pris ne dira" (BEdT 420,002), but he is not included in either of Steel's repertoires. Both of these melodies are discussed in detail in Chapter II, Case Study 1.

Although this selection of troubadours facilitates his comparison of sources, these troubadours are not, in general, representative of the melodic repertory. The authors chosen here all ceased activity by 1205, but troubadour activity continued through the end of the century (and including Matfre Ermengau, into the early fourteenth century). Although three of these six troubadours are among the most-widely transmitted troubadours overall, there is a significant difference between the number of songs extant by these troubadours. Bernart has five times the number of extant melodies as Jaufre overall, and four times as many included in Steel's repertory for analysis. Jaufre and Richart have only one song each in Steel's limited corpus, while Gaucelm has six (five with three melodic concordances and one with four).[264] These limitations acknowledged, I begin by comparing his results, derived from his limited corpus, to those from the melodies in the TMD and evaluating the differences; then, I discuss my analysis of the entire contents of *G, R, W* and *X*.

Steel's computation results in the following ranking of manuscripts by their PPS values, moving from least to most melismatic in character. His calculations are for one hundred and eight melodies by the six troubadours who are the focus of his study rather than only those with concordances in at least three sources (see Figure 3.38).[265]

[264] Jaufre has six melodies extant total; Richart has eight.
[265] Steel, "Influences," 103. If these values are calculated for the fifty-five songs only, the values are as follows: *G*: 1.573; *R*: 1.562; *W*: 1.74; and *X:* 1.807. The values for *G/R* are the same or nearly so, but those for *W/X* are significantly higher for the subset of the songs than for all songs by the six troubadours.

Ms	Steel's PPS
R	1.524
G	1.573
W	1.618
X	1.654

Figure 3.38: Average PPS of G, R, W and X calculated by Steel

For reference, the average PPS for the entire repertory from Steel's analysis is 1.596, placing the two troubadour manuscripts below the overall average and the two trouvère manuscripts above it. The lowest and highest averages by source span 0.13 pitches per syllable across the four sources. Steel notes in his discussion of this feature of the manuscripts that his calculations would be altered if his methods accounted for *plicas*:

> …if all the plicas of MS W were realized in its pitch density calculations, MSS X and W would be remarkably close in pitch density scores.[266]

When Steel's values are juxtaposed with the PPN values from my analysis, the manuscript order changes; however, the overall range of the four manuscripts' PPN values is 0.13, the same as that of the values calculated by Steel (see Figure 3.39). The values calculated without *plicas* are included in the last column; these differ only slightly from Steel's results with the exception of *W*, which is 0.08 higher in the TMD PPN value without *plicas*.[267]

[266] Steel, "Influences," 121.
[267] For context, *G* has fifteen melodies with *plicas*; *R* has sixty-six; *W* has fifty-three; and *X* has two.

Ms	Average PPN (TMD)	Average PPN without *Plicas* (TMD)
R	1.54	1.525
G	1.58	1.575
X	1.67	1.663
W	1.75	1.699

Figure 3.39: Average PPN values for 108 melodies in Steel's study from TMD

While Steel correctly predicted *W*'s melismatic score would increase with the inclusion of *plicas*, instead of being close to the score of *X*, it is instead 0.8 pitches higher (previously *X* was 0.3 pitches higher than *W*). Thus, the inclusion of *plicas* in fact increased the distance between the two manuscripts because of the high number of *plicas* in *W*.

When the same analysis is conducted on the entire contents of *G, R, W* and *X*, the results are nearly identical for Steel's PPS values versus the TMD's PPN values for *R* and *G*, with a slightly larger difference for *X*. *W's* values are the most different from Steel's calculations when *plicas* were included in the computations because of its significantly higher rate of appearance of *plicas* compared to the other sources.[268] Figure 3.40 below presents the average PPN values for each manuscript according to Steel's PPS values for each song, the TMD's values without *plicas*, and the TMD's values with *plicas*.

[268] *W* not only has a high rate of songs with *plicas*, but also tends to have more *plicas* per melody than is typical in the other sources.

Ms	Steel PPS	TMD PPN without *Plicas*	TMD PPN with *Plicas*
G	1.533	1.533	1.537
R	1.658	1.648	1.664
W	1.513	1.547	1.618
X	1.624	1.629	1.634

Figure 3.40: Comparison of Steel's PPS to TMD's PPN for G, R, W and X

Here, the most melismatic source is *R* by all three sets of calculations. The least melismatic source is *G* based on the PPN values calculated from the TMD both with and without *plicas* included; however, *W* has the lowest PPS by Steel's values (because, as noted previously, he does not count *plicas* within the pitch totals). In this expanded set of comparisons, Steel's prediction of the similarity between *X* and *W* if *plicas* were considered is accurate, making them 0.016 apart instead of 0.111.

The comparison of all the melodies in *G, R, W* and *X* with and without *plicas* also confirms that the higher number of *plicas* notated in *W* factor into its melismatic character. *Plicas* impact the melismatic quality of many melodies to only a small degree (about a third of the melodies with *plicas* have only one). However, in the case of melodies with a substantial number of *plicas* (roughly a third have five or more), they increase the number of syllables set neumatically and melismatically. They also constitute one of the clear differences in style between the main four music manuscripts because of the significantly higher percentage of melodies with *plicas* found in *W* compared to the other sources (all but two of the melodies in *W* have at least one *plica*). Comparison of the results of Steel's pitch density analysis to my analysis of the full melodic contents of *G, R, W* and *X* thus demonstrates the difficulty of extrapolating characteristics from a subset of the repertory onto the entire body of surviving melodies.

The second statistical analysis Steel computed for his subset of the repertory compared the four main sources based on their use of non-stepwise motion. He outlines the results of this comparison using two groups of intervals: all intervals of a third and larger and all intervals larger than a third.[269] He applied this type of analysis to the 108 melodies by the troubadours he analyzed for pitch density above. His results are summarized in Figure 3.41 below; for context, the melodies in *G, R, W* and *X* have 15.7% intervals larger than a third and 3.14% intervals larger than a fourth, based on my analysis of those melodies. As with the previous discussion of Steel's pitch density, I ran intervallic analysis on the entire contents of *G, R, W* and *X* to compare Steel's results for the group of six troubadours to those of the core overall.[270] Those results appear in Figure 3.41 with the averages for the TMD both without and with *plicas* for comparison. Since *plicas* typically fill in an interval of a third, the values for intervals a fourth and larger are less affected than thirds by the removal of *plicas* from the calculation.

	Steel (6 troubadours)		**TMD (without *plicas*)**		**TMD (with *plicas*)**	
Ms	**Third+**	**Fourth+**	**Third+**	**Fourth+**	**Third+**	**Fourth+**
G	17.98	2.61	20.21	4	20.79	4.11
R	12.86	1.438	16.35	2.56	16.16	2.55
W	15.76	1.83	28.07	6.8	21.03	5.35
X	13.87	2.24	19.3	4.7	19.3	4.74

Figure 3.41: Average number of intervals per melody for Steel's six troubadours and TMD

From Steel's computations, the six troubadours' works within the four main manuscripts are quite different in their rate of usage of intervals of a third and larger, but are more similar for intervals larger than a third. The values increase to different extents between Steel's selected

[269] Steel, "Influences,"104-105.
[270] I excluded the two *lais* and *descorts* in *W* because they greatly skew the average per song due to their considerable length compared to nearly all other troubadour songs.

corpus and the entire core repertory. The largest change is seen in *W*, whose average number of intervals larger than a third increased by over ten intervals per song in my expanded analysis. *R* has the smallest change, with an average of three more intervals a third and larger per melody. However, the order of the manuscripts in terms of how frequently each group of intervals appears is nearly the same as in Steel's reduced data set. The exception is that *W* has the most examples of larger intervals rather than *G* across the larger repertory, and *X* has more intervals of a fourth and larger than *G* (making the order from least to highest *R/G/X/W*). *R* is ranked last for both categories of intervals; further, it has the largest difference between its values and those of the next closest manuscript for both values as well. *G* and *W* are the most similar in these terms, with *X* close in similarity to both as well. When the ranking for interval appearances from lowest to highest values (*R/X/W/G* for thirds+, *R/G/X/W* for fourths+) is compared to those for PPN (*G/W/X/R*), the relationship changes. *R* becomes the most melismatic of the sources, and has more stepwise motion in its melodies than that found in the other three main music manuscripts. This conclusion thus contradicts one of Steel's claims (that *G* is the least melismatic source) while confirming that *R* does have the highest percentage of stepwise motion among the four manuscripts.

In addition to broadening the corpus of melodies analyzed by Steel for their use of leaps, my analysis of the melodies allows a more granular division for comparison of interval usage than simply intervals of a third and larger or a fourth and larger. The number of intervals a third or greater in *G, R, W* and *X* are compared by source in the figure below; they are also compared to the values based on the six troubadours which form the focus of Steel's study.

Average Intervals per Melody (TMD)

Ms	3rd	4th	Tritone	5th	6th	7th	8ve	9th	10th	11th
G	16.2	2.21	0.22	1.25	0.23	0.05	0.04	0.01	0	0
R	13.52	1.24	0.11	1.07	0.11	0.02	0.05	0.01	0	0.01
W	19.65	2.78	0.31	2.2	0.51	0.35	0.4	0.02	0.02	0
X	14.57	2.48	0.74	1.52	0.48	0.22	0	0	0	0

Average Intervals per Melody (Steel's 55 Melodies)

Ms	3rd	4th	Tritone	5th	6th	8ve	9th	10th
G	18.59	2.47	0.24	1.71	0.65	0.12	0.06	0
R	15.81	2.13	0	1.13	0.13	0	0	0
W	15.15	1.23	0.31	1.31	0.38	0.15	0	0.08
X	16.75	4.13	0	2.38	0.63	0	0	0

Figure 3.42: Comparison of average no. of intervals per manuscript by size

As the comparison demonstrates, there is not only a significant drop in frequency between thirds and intervals a fourth and higher, which could be observed in the comparison of two groups of intervals discussed previously, but also a steep decline in frequency as interval size increases. The detailed breakdown of intervals also reveals that the melodies in *X* contain no intervals larger than a seventh, while only *R* contains an interval of an eleventh, and only *W* an interval of a tenth. When the repertory is reduced to those in Steel's study, several of the larger intervals are not represented in each source they actually appear in (the same is true for the tritone). The interval appearances in the subset also do not differ in a consistent way from that of all of the melodies in *G, R, W* and *X* (all too high or too low) but are a mix of degrees of difference. This comparison thus demonstrates the difficulty of extrapolating conclusions based on a subset of the repertory as well as the benefits of detailed analysis of specific features compared to evaluating features as groups.

By drawing on the data gathered for source comparison by interval size and their average number of pitches per neume, the role that the *plica* plays in the intervallic content and melismatic quality of melodies can be assessed directly. 146 melodies in the troubadour repertory include at least one *plica*; half of these melodies are unica. The melody with the most *plicas*, Guiraut d'Espaigna's "Be volgra, s'esser pogues" (BEdT 244,001a), has seventeen and is a late-thirteenth-century addition to *W*. From the discussion above, it is already been established that *W* has the most *plicas* overall. However, *R* has the highest number of individual melodies with *plicas* (sixty-six); *W* is second with fifty-three, *G* has seventeen, and *X* has only two (they are less common in Messine notation typically). For about half of melodies with concordances, both (or all) versions have *plicas*. As seen previously, *plicas* can impact the intervallic structure of melodies by increasing the amount of stepwise motion; while this is a slight change for a majority of melodies, *W*'s concentration of *plicas* causes a reduction in the average number of thirds per melody. John Haines calculated the number of *plicas* per melody for the entirety of *W* (five) as well as several other manuscripts, including *R* (two), based on the number of *plicas* per melody with at least one *plica* rather than the overall number of melodies in the source .[271] Taking the same approach for the troubadour section of *W* and the other three main sources, I determined the following averages for *plicas* per melody: *G* (1.3), *R* (2.2), *W* (8.3), *X* (2).[272] The troubadour section of *W* thus has a higher rate of appearance of *plicas* than the entire source, in addition to having an average number of *plicas* quadruple that of the other sources.

Based on the evaluation of the melodic features examined here, several conclusions are evident. Generally, the comparisons above demonstrate that while Steel's statistical analysis of

[271] Haines, "Musicography," 184.
[272] Steel calculates the following average *plicas* per melody by source: *R* (0.95), *X* (0), *W* (8). He describes *G*'s *plica* usage as "average." Steel, "Influences," 104, 115, and 118.

the limited repertory is an accurate reflection of the pitch density and frequency of leaps found in those melodies, when the same analytical procedures are applied to the full contents of the four manuscripts, the results differ significantly in several cases. This discrepancy reinforces to the difficulty noted previously of considering analysis of a subset of the troubadour melodic repertory as representative of the whole. In the case of certain parameters, some similarities may exist between the subgroup and the melodies overall (such as in the frequency of d' as a final pitch, as discussed in Chapter I). However, this cannot be relied upon, as demonstrated by the not only different individual values, but also the change in order and relationship between manuscripts which had the most or least of the parameters evaluated by Steel. From my analysis of the entire repertory, I can state that there is, as noted above, a trend for *R*'s melodies to be more melismatic and to have a greater percentage of stepwise motion when compared to the analysis output from the other sources. Further, the case study contributes a statistical evaluation of style in the main sources while validating or updating Steel's conclusions. It also contributes the first systematic statistical comparison of troubadour melody features with and without *plicas*, as well as generating a dataset about *plica* appearances by melody and source. From the latter analysis, I determine that not only does *W* have the most melodies with *plicas*, it has the most melismas per melody as well.

Conclusion

Here, I have analyzed the melodies in connection with several previous studies and approaches, considering several ways in which the musical style of the troubadours can be approached (including their sources, time period, and elements of their internal pitch organization). My analysis, drawn from digital and computational musicology, surveys the

repertory broadly for a wide range of features; while it is not the first study to utilize computational approaches to this repertory, it is one of the few to consider the entire repertory, rather than a subsection, and has the broadest coverage of musical characteristics available for analysis. This presents the opportunity to create a comprehensive dataset about the melodies which can form the basis for analysis of the melodies individually and within particular groups to establish trends in musical style at a given point in time, within a particular manuscript, or within the melodies attributed to a specific troubadour. It also provides an established and specific set of characteristics that can be used to contextualize and asses any proposed editorial emendations to the melodies as transmitted and for comparison to other repertories.

From comparisons of the melodies based on their sources, there are certain trends evident pointing to a higher degree of similarity in the melodies in *W* and *X* compared to *R* and *G*, while also showing a significant amount of consistency in terms of the pitchscape inhabited by the melodies (determined by their boundary notes and ranges) across the sources. No one source demonstrates that particular pitches (such as final or first notes) or intervals (either in terms of range or the first and final intervals of a melody) played a determining factor in the inclusion of melodies in a source, or in the internal organization of melodies within a troubadour's output. Among the four main musical sources, *X* demonstrates the most differences in traits with respect to the other sources overall, including the range and three of the boundary pitches. This is likely a result of its early date, which restricts its contents to songs composed prior to 1250, roughly a half century before the notation of *G* and *R*, and at least a decade prior to the notation of *W*. *W* itself, as concluded in the final case study, stands out in the frequency of *plicas* in its melodies, containing more both in terms of percentage of its melodies which include at least one *plica* as well as in the number of *plicas* found in individual melodies. Its prevalent use of the *plica* is

significant enough to have a noticeable impact on its rate of appearance of thirds and its number of pitches per neume.

With respect to the evaluation of musical features of the corpus over time, this study concluded that the existing generational divisions of the melodic repertory is problematic for analysis because its unequal division of the repertory results in groups of melodies too small to be analyzed for trends. Instead, a more even division of the melodies, based on the end dates of troubadours, permits generalizations about groups of melodies composed roughly contemporaneously while still reflecting traits on a more granular level by not reducing the melodies into such large periods that a remarkable consistency of features is the most noticeable tendency. Discerning trends in the pitch organization of melodies, particularly with respect to patterns in when (or where) melodies reflect the greatest number of modal structures reveals some specific tendencies while concluding that such trends lack a connection to a particular source or scribe overall.

Conclusions

Over the course of the five case studies in the previous chapters, I have applied computational and statistical methods to the troubadour melodies to examine their musical features at both large and small scales, ranging from examination of one troubadour's style to describing the musical trends in individual sources. These studies demonstrate the range of applications possible for music analysis while refining and expanding current perspectives on the repertory. These case studies relate to the larger goal of this dissertation: to clarify the musical characteristics of the repertoire based on encoded diplomatic transcriptions of the melodies; to evaluate and revise current views on troubadour melody; and to contribute additional perspectives on the repertory.

In Chapter II, I analyzed the melismatic writing of Guiraut Riquier with corpus analysis software to identify the individual musical components of his melodies, their rates of appearance, and the musical features of his melismas (including their ambitus, first and final pitches, and whether they are entirely stepwise or contain leaps). My analysis corroborates Chantal Phan's position that melismas are essential structural components of Riquier's melodies, rather than simply serving as ornamentation; to her conclusions on the significance of melismas for keywords and aspects of metrical structure, I added that the Riquier's melismas appear primarily in positions other than at cadences or serving as the penultimate gesture at a cadence. I then placed his melismatic writing within the context of the entire repertory; he is the only troubadour with more than three melodies with a majority of melismas not at cadences (comparison with

other troubadours with a substantial number of surviving melodies shows lower percentages of melismas not at cadences and a lower average number of melismas per melody than I calculated for Riquier).[273] Based on the data set I gathered for this case study, I determined that Riquier does follow the overall trend of the corpus by having a larger number of melismas at or next to internal cadences compared to final ones. His melismas are nearly all stepwise and none have a leap larger than a third; this is typical of melismas in the repertory, although there are melismas with larger leaps in melodies by other troubadours. Riquier's melismas nearly all stay within the range of a third or fourth; only ten percent of his melismas span a second, fifth, or seventh.[274]

In the second case study in Chapter II, I leveraged Latent Semantic Analysis (LSA) to compare melodies with concordances and to measure the degree of similarity between them. I then applied the same technique to compare phrases of the melodies in manuscript *G* which have notation for more than one stanza. I also compared the two melodies which have two full notated stanzas as well as the first phrase of stanza 3; while the second stanzas have been transcribed previously in some editions, the third stanza phrase has not typically been included in editions or discussions of these melodies. This procedure identified which of the melodies have identical first phrases for both stanzas, which have small differences, and which were dissimilar. In a majority of cases, the melodies for the second (or third) stanza is identical in pitch to that of the first, but have small variations in text underlay to accommodate the different text (or possibly as a result of scribal error). Two melodies include a second stanza incipit which is entirely different from that of the first stanza; one is a clear case of scribal error in which the scribe copied the previous song's musical incipit over again. The second case, that copied for the second stanza of

[273] The closest are Gaucelm Faidit and Folquet de Marseilla, who both have approximately thirty melodies in which around thirty-five percent of their melismas are not at cadences. They also both have less than four melismas per melody on average; Riquier has eight.
[274] The repertory overall has about twenty percent of its melismas with ranges other than a third or fourth.

Aimeric de Pegulhan's "Atressi·m pren com fai al jogador" (BEdT 10,012), is more difficult to explain, as the only melodic incipit in the repertory which matches it is that of Bernart de Ventadorn's "Lanquan foillon bosc e garric" (BEdT 70,024), a melody which is unique to *W*; the text of the song appears in two other sources, both made in Occitania.[275] There are also notational differences in the notated second stanzas with differences in the shapes of binaria and ternaria. Since the musical hand in G is the same throughout the source, this could mean that the exemplar for the second stanza came from a different scribe than that of the first stanzas. The additional space needed to copy both stanzas with notation also demonstrates that the scribe planned to include both melodies for these specific songs early in the compilation of the manuscript. In addition to the two with notation for both stanzas, there are two other songs which have one notated stanza with empty staves provided for the second stanza, making a total of four songs which the scribe laid out for two stanzas of melody.

The three case studies in Chapter III each explored the musical characteristics of subgroups of the repertory by applying different methods of pitch and interval. In the first case study, I described the musical characteristics of the melodies composed by Elizabeth Aubrey's third and fourth generation troubadours before concluding that the uneven distribution of melodies in her generations limits their usefulness for analysis which seeks to describe changes in style over time. My proposed chronological grouping of the melodies is formed from more similarly-sized subgroups which are sufficient for analysis; this allows me to discern general traits in musical style at the different points of time represented in each group (late twelfth

[275] Manuscripts *C* and *E*. There is also no evidence of a contrafact based on this melody appearing in *G*, as the only other song with the same rhyme scheme is a *cobla* in a text-only source, *P*. A similar passage is found internally in the three versions of Gaucelm Faidit's "Si anc nuls hom per aver fi coratge" (BEdT 167,052) in *G/R/X* and in Folquet de Marseille's "S'al cor plagues, be for'oimais sazos" (BEdT 155,018) in *G*. Neither of the two songs in *G* with a similar passage appears in close proximity to "Atressi·m pren com fai al jogador."

century, early thirteenth century, etc.) Based on comparison of the features of these groups, trends are evident that are obscured in Aubrey's discussion. While it is true (as seen in the previous chapter with the melodies of Riquier) that the last troubadours wrote more melismatically than typical of most of their predecessors, there are also a significant number of melismatic songs in the first period which are the most melismatic songs (by average pitches per neume) until the final period. Since the melodies of the late twelfth century are more melismatic overall than those of the early-mid thirteenth century, there is thus not a straightforward trend towards increasingly melismatic writing. Instead, the evidence shows a decrease just prior to the beginning of the thirteenth century and only later a steep increase from mid-century onwards. This point also supports an overall observation in this dissertation, which notes that any perspective which views troubadour melody as consistently moving from simple to complex is not supported by the musical evidence.

The second case study approached the evidence of pitch organization in the melodies, particularly the structures of the church modes. I analyzed the musical features which define the church modes (final, ambitus, and range both above and below the final) as well as other forms of musical emphasis (repetition of pitches and the position of notes at the beginnings and ends of phrases). I first presented the occurrence of these musical features in the repertory overall, then demonstrated how pitch organization relates to modal analysis of the melodies and the 'chains of thirds' concept applied to analysis of the melodies by some scholars. I do not see evidence that chains of thirds are present in the structural significant positions I examined. I also conclude that, while the modal system derived from the chant repertory was likely influential for troubadours to different degrees, there is no consistent application of modal pitch organization in their melodies.

The final case study evaluated and expanded the statistical analysis of general features of the troubadour melodies undertaken by Matthew Steel in his 1989 dissertation, which analyzes a subset of melodies from the main sources only. I applied the same types of analysis to the entire contents of the four main sources, concluding that his results are in some cases inconsistent with those of the repertory overall. I also determined that the subset he chose to analyze is not representative of the larger repertory, in general; further, the amount of variety seen in the melodies make generalizing about its features based on a subset difficult. As a final step in this case study, I incorporated the *plica* into the discussion of both the text-setting and intervallic profile of melodies, filling a gap in Steel's study as his computations were not designed to account for *plicas*. This additional step of the analysis demonstrated the exact extent of *plica* usage in the sources and the degree to which *plicas* impact the melismatic writing and number of leaps in a melody; I concluded that this is primarily significant for *W* because of its much higher number of *plicas* than seen in other sources.

Future aims of the Troubadour Melodies Database

It is my hope that future research will benefit from the resources I created for this project and build on the analysis I have conducted here, both for further studies of the troubadours and of other encoded corpora. The data and other materials generated for this project are available through the TMD, including the melodies, the table of reference musical characteristics, and the visualizations discussed in the dissertation, and the data sets they are based on. The TMD also includes files with transformations of the melodies as interval profiles, strings of neume lengths, and as simple directional contours.

Facilitating comparison of the features of the troubadour melodies to other traditions (both monophonic and polyphonic) is another long-term goal of this project. In the previous chapters, I delineated the musical features of the repertory in terms of individual melodies, different subgroups of the repertory, and entire sources. The next step in advancing our understanding of the music of the troubadours is thus to place their musical style within the wider context of medieval song by comparing its features to that of other repertories once other bodies of song are encoded and available for analysis. One of the most important of these comparisons is analysis of the similarities and differences between the songs of the troubadours compared to those of the trouvères. Often, troubadour and trouvère melody are grouped together in both discussions and editions; however, a systematic comparison of the two repertoires is necessary to establish exactly how similar (or dissimilar) they are musically. This dissertation has taken the first steps in filling in this gap in our knowledge by identifying or making the tools necessary for this type of analysis and by establishing the musical features of the troubadour melodies for future comparisons.

In addition to repertory-based analytical comparison between the troubadours and other secular traditions, it is also important to establish how the musical features of troubadour melody align with those found in contemporary chant. This will enhance our understanding of how the two repertoires are linked (or differentiated) through their typical musical characteristics; this approach will thus expand on the discussion of pitch organization in the melodies and its relationship to the church modes by providing a detailed comparison of a wider range of melodic features in representative chant and the troubadour melodies.

Beyond extending the scope of my analysis outside the troubadour repertory, I also plan to continue to expand the types of digital approaches used for the analysis and discussion of the

melodies. This includes close study and mapping of the patterns of actual and intended transmission of troubadour melody based on all extant manuscript evidence. Such an approach will allow me to more accurately describe the extent of musical transmission and the circulation of the songs while also tracking geographical locations where particular types of musical transmission occur (for example, if manuscripts from a certain region have less notation or musical planning compared to other areas, or if there are the chronological trends in the distribution of different levels of musical transmission).

Part of this expanded approach will focus on the networks of transmission of the musical sources, focusing on manuscript relationships based on both their contents and their features. This will be accomplished by joining the current data on the tradition with two different approaches to visualization: network graphs and geographical maps. Network graphs represent how different entities, such as people, institutions, or objects, are connected; these graphs are a dynamic approach to data visualization that allows multiple features of the entities and relationships in the graph to be represented. The maps will visualize the origins of the manuscripts and songs based on our current knowledge of the origins of the sources; these will also include the option to filter the map's contents by various facets, including by the dates of sources. Both of these tools will also integrate selected musical features drawn from the analysis in this dissertation to incorporate the characteristics of the melodies into the representation of transmission wherever possible. I plan to add these materials to the TMD in due course, along with their data sets.

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Appendix A: Troubadours with Extant Melodies

This appendix provides a list of all troubadours with extant melodies who appear in the dissertation, either through direct reference in the prose or through inclusion in one or more of its digital components. Each troubadour is listed with their BEdT ID, dates, generation from Aubrey, generation from the BEdT, end date for their activity, and their period in the division of the repertoire outlined in Chapter III.

Troubadour	BEdT ID	Dates (fl.)	Aubrey Generation	BEdT Gen.	End Date (Ch. III)	Period (Ch. III)
Aimeric de Pegulhan	10	1190-1225	4th (1180-1240)	4	1225	C.I (1226-1275)
Albertet de Sestaro	16	1194-1221	4th (1180-1240)	4	1221	B.II (1206-1225)
Arnaut Daniel	29	1180-1200	3rd (1160-1210)	3	1200	B.I (1200-1205)
Arnaut de Maroill	30	1171-1195	3rd (1160-1210)	3	1195	A.II (1181-1199)
Beatriz de Dia	46	late12th / early13th century	3rd (1160-1210)	3	1200	B.I (1200-1205)
Berenguier de Palazol	47	1160-1209	3rd (1160-1210)	2	1209	B.II (1206-1225)
Bernart de Ventadorn	70	1147-1180	2nd (1140-1180)	2	1180	A.I (1126-1180)
Bertran de Born	80	1175-1200	3rd (1160-1210)	3	1200	B.I (1200-1205)
Blacasset	96	1233-1242	5th (1210-1255)	5	1242	C.I (1226-1275)
Cadenet	106	1204-1238	4th (1180-1240)	4	1238	C.I (1226-1275)
Daude de Pradas	124	1214-1282	6th (1230-1300)	4	1282	C.II (1276-1322)
Folquet de Marseilla	155	1178-1195	3rd (1160-1210)	3	1195	A.II (1181-1199)
Gaucelm Faidit	167	1170-1202	3rd (1160-1210)	3	1202	B.I (1200-1205)
Guillaume IX, Count of Poitiers	183	1071-1126	1st (1120-1150)	1	1126	A.I (1126-1180)
Granet	189	1240-1257	6th (1230-1300)	5	1257	C.I (1226-1275)
Gui d'Uisel	194	c.1195	3rd (1160-1210)	4	1195	A.II (1181-1199)
Guillem Ademar	202	1195-1217	4th (1180-1240)	4	1217	B.II (1206-1225)
Guillem Augier Novella	205	1209-1230	4th (1180-1240)	4	1230	C.I (1226-1275)
Guillem de Saint Leidier	234	1165-1200	3rd (1160-1210)	3	1200	B.I (1200-1205)
Guillem Magret	223	1195-1210	3rd (1160-1210)	3	1210	B.II (1206-1225)
Guiraut de Borneill	242	1160-1200	3rd (1160-1210)	2,3	1200	B.I (1200-1205)
Guiraut d'Espaigna	244	1245-1265	6th (1230-1300)	5	1265	C.I (1226-1275)
Guiraut Riquier	248	1254-1292	6th (1230-1300)	6	1292	C.II (1276-1322)
Jaufre Rudel de Blaja	262	1125-1148	1st (1120-1150)	1	1148	A.I (1126-1180)
Jordan Bonel, de Cofolen	273	1150-1200	3rd (1160-1210)	3	1200	B.I (1200-1205)
Marcabru	293	1129-1149	1st (1120-1150)	1	1149	A.I (1126-1180)
Matfre Ermengau	297	1280-1322	6th (1230-1300)	6	1322	C.II (1276-1322)
Monge de Montaudo	305	1193-1210	4th (1180-1240)	3	1210	B.II (1206-1225)
Peire Cardenal	335	1205-1272	6th (1230-1300)	4,5	1272	C.I (1226-1275)
Peire d'Alvergne	323	1149-1170	2nd (1140-1180)	2	1170	A.I (1126-1180)
Peire Raimon de Toloza	355	1180-1221	4th (1180-1240)	3--4	1221	B.II (1206-1225)
Peire Vidal	364	1183-1205	3rd (1160-1210)	3	1205	B.II (1206-1225)
Peirol	366	1188-1222	4th (1180-1240)	3	1222	B.II (1206-1225)
Perdigon	370	1190-1212	4th (1180-1240)	4	1212	B.II (1206-1225)
Pistoleta	372	1205-1228	4th (1180-1240)	4	1228	C.I (1226-1275)
Pons de Capdoill	375	1190-1237	4th (1180-1240)	3	1237	C.I (1226-1275)

Troubadour	BEdT ID	Dates (fl.)	Aubrey Generation	BEdT Gen.	End Date (CH.III)	Period (Ch. III)
Pons d'Ortafas	379	1217-1240	5th (1210-1255)	4	1240	C.I (1226-1275)
Raimbaut d'Aurenga	389	1162-1173	2nd (1140-1180)	2	1173	A.I (1126-1180)
Raimbaut de Vaqueiras	392	1180-1205	3rd (1160-1210)	3	1205	B.II (1206-1225)
Raimon de Miraval	406	1191-1229	4th (1180-1240)	3	1229	C.I (1226-1275)
Raimon Jordan	404	1178-1195	3rd (1160-1210)	3	1195	A.II (1181-1199)
Richart de Berbezill	421	1140-1163	2nd (1140-1180)	3	1163	A.I (1126-1180)
Uc Brunet	450	1190-1200	4th (1180-1240)	3	1200	B.I (1200-1205)
Uc de Saint Circ	457	1217-1253	5th (1210-1255)	4	1253	C.I (1226-1275)

Appendix B: Melody Concordance in Relevant Editions and Studies

This appendix lists all of the melodies in the TMD and their appearance and/or inclusion in studies and editions referenced in the project. This includes Elizabeth Aubrey's *Music of the Troubadours*;[1] Friedrich Gennrich's *Der musikalische Nachlass der Troubadours*;[2] David Halperin's "Structural Analysis";[3] Matthew Steel's "Influences on the musical style of the troubadours";[4] Hendrik Van der Werf's *Extant Troubadour Melodies*;[5] and Claudio Vanin's "Musical Form and Tonal Structure in Troubadour Song."[6] For most of these studies and editions, the table lists only if a melody is included (y), not included (blank), or specifically excluded (excluded). For Steel, the songs are labeled as core or satellite to reflect his division of the repertoire. For Gennrich, the number assigned to each melody in the edition is listed. Each occurrence of a melody is included in the table individually; songs are identified by their BEdT catalog number and manuscript so that the table shows which melody versions are included (or excluded) from studies. Melodies so fragmentary they were excluded from much of the analysis here are listed as fragments in the final column of the table. Those melodies in *G* which have part of the second stanza notated are marked with an asterisk next to the manuscript name in the second column; melodies with the full second stanza notated are marked with two asterisks.

[1] Elizabeth Aubrey, *The Music of the Troubadours* (Bloomington: Indiana University Press, 1996).
[2] Friedrich Gennrich, *Der musikalische Nachlass der Troubadours*, 3 vols. (Darmdstadt: [Gennrich], 1958-1965).
[3] David Halperin, "A Structural Analysis of Troubadour Song" (Master's thesis, Tel Aviv University, 1978).
[4] Matthew Steel, "Influences on the Musical Style of the Troubadours of the Twelfth and Thirteenth Century Southern France" (PhD diss., The University of Michigan, 1989).
[5] Hendrik Van der Werf, *The Extant Troubadour Melodies: Transcriptions and Essays* (Rochester, NY: Hendrik Van der Werf, 1984).
[6] Claudio Vanin, "Musical Form and Tonal Structure in Troubadour Song" (Ph.D. diss., University of Western Ontario, 1994).

BEdT No.	Ms	TMD ID	Aubrey	Genn. No	Halperin	Steel	Van der Werf	Vanin	Ch. III Periods
010,012	*G**	10012	y	177	y	core	y	y	C.I
010,015	*G*	10015	y	178	y	core	y	y	C.I
010,025	*G*	10025G	y	179	y	core	y	y	C.I
010,025	*R*	10025R	y	179	y	core	y	y	C.I
010,027	*G**	10027	y	180	y	core	y	y	C.I
010,041	*G**	10041	y	181	y	core	y	y	C.I
010,045	*R*	10045R	y	182		core	excluded		C.I
010,045	*W*	10045W	y	182		core	excluded		C.I
016,005a	*W*	16005a	y	189	y	core	y		B.II
016,014	*W*	16014	y	190	y	core	y		B.II
016,017a	*X*	16017a	y	191	y	core	y		B.II
029,006	*G**	29006	y	90	y	core	y		B.I
029,014	*G*	29014	y	91	y	core	y		B.I
030,003	*G**	30003	y	49	y	core	y	y	A.II
030,015	*R*	30015	y	50	y	core	y	y	A.II
030,016	*R*	30016	y	51	y	core	y	y	A.II
030,017	*R*	30017	y	52	y	core	y	y	A.II
030,019	*G*	30019	y	53	y	core	y	y	A.II
030,023	*R*	30023	y	54	y	core	y	y	A.II
046,002	*W*	46002	y	38	y	core	y		B.I
047,001	*R*	47001	y	40	y	core	y	y	B.II
047,003	*R*	47003	y	41	y	core	y	y	B.II
047,004	*R*	47004	y	42	y	core	y	y	B.II
047,005	*R*	47005	y	43	y	core	y		B.II
047,006	*R*	47006	y	44	y	core	y		B.II
047,007	*R*	47007	y	45	y	core	y	y	B.II
047,011	*R*	47011	y	46	y	core	y	y	B.II
047,012	*R*	47012	y	47	y	core	y	y	B.II

BEdT No.	Ms	TMD ID	Aubrey	Genn.No	Halperin	Steel	Van der Werf	Vanin	Ch. III Periods
070,001	*G**	70001G	y	16	y	core	y	y	A.I
070,001	*R*	70001R	y	16	y	core	y	y	A.I
070,001	*W*	70001W	y	16	y	core	y	y	A.I
070,004	*R*	70004	y	17	y	core	y		A.I
070,006	*G**	70006G	y	18	y	core	y	y	A.I
070,006	*R*	70006R	y	18	y	core	y	y	A.I
070,007	*G**	70007G	y	19	y	core	y	y	A.I
070,007	*R*	70007R	y	19	y	core	y	y	A.I
070,007	*W*	70007W	y	19	y	core	y	y	A.I
070,008	*R*	70008	y	20	y	core	y		A.I
070,012	*G**	70012G	y	21	y	core	y	y	A.I
070,012	*R*	70012R	y	21	y	core	y	y	A.I
070,016	*G**	70016G	y	22	y	core	y	y	A.I
070,016	*R*	70016R	y	22	y	core	y	y	A.I
070,017	*G*	70017	y	23	y	core	y		A.I
070,019	*W*	70019	y	24	y	core	y		A.I
070,023	*R*	70023R	y	25	y	core	y	y	A.I
070,023	*X*	70023X	y	25	y	core	y	y	A.I
070,024	*W*	70024	y	26	y	core	y		A.I
070,025	*R*	70025	y	27	y	core	y		A.I
070,031	*G***	70031G	y	28	y	core	y	y	A.I
070,031	*W*	70031W	y	28	y	core	y	y	A.I
070,036	*G**	70036G	y	29	y	core	y	y	A.I
070,036	*R*	70036R	y	29	y	core	y	y	A.I
070,039	*R*	70039	y	30	y	core	y		A.I
070,041	*G*	70041G	y	31	y	core	y	y	A.I
070,041	*R*	70041R	y	31	y	core	y	y	A.I
070,041	*W*	70041W	y	31	y	core	y		Fragment

BEdT No.	Ms	TMD ID	Aubrey	Genn.No	Halperin	Steel	Van der Werf	Vanin	Ch. III Periods
070,042	*X*	70042	y	32	y	core	y		A.I
070,043	*G**	70043G	y	33	y	core	y	y	A.I
070,043	*R*	70043R	y	33		core	y	y	A.I
070,043	*W*	70043W	y	33		core	y	y	A.I
070,045	*W*	70045		34		core	y		Fragment
080,037	*R*	80037	y	39	y	core	y		B.I
096,002	*W*	96002	y	192	y	core	y		C.I
106,014	*R*	106014	y	183	y	core	y		C.I
124,005	*W*	124005	y	159	y	core	y		C.II
155,001	*G*	155001G	y	77	y	core	y	y	A.II
155,001	*R*	155001R	y	77	y	core	y	y	A.II
155,003	*G**	155003G	y	78	y	core	y		A.II
155,003	*R*	155003R	y	78	y	core	y		A.II
155,005	*G**	155005G	y	79	y	core	y	y	A.II
155,005	*R*	155005R	y	79	y	core	y	y	A.II
155,008	*G**	155008	y	80	y	core	y		A.II
155,010	*G**	155010G	y	81	y	core	y	y	A.II
155,010	*R*	155010R	y	81	y	core	y	y	A.II
155,010	*W*	155010W	y	81	y	core	y	y	A.II
155,011	*G**	155011	y	82	y	core	y		A.II
155,014	*G*	155014G	y	83	y	core	y	y	A.II
155,014	*R*	155014R	y	83	y	core	y	y	A.II
155,016	*G*	155016G	y	84	y	core	y		A.II
155,016	*R*	155016R	y	84	y	core	y		A.II
155,018	*G**	155018G	y	85	y	core	y	y	A.II
155,018	*R*	155018R	y	85	y	core	y	y	A.II
155,021	*G**	155021G	y	86	y	core	y		A.II
155,021	*W*	155021W	y	86	y	core	y		Fragment

BEdT No.	Ms	TMD ID	Aubrey	Genn.No	Halperin	Steel	Van der Werf	Vanin	Ch. III Periods
155,022	*G**	155022G	y	87	y	core	y	y	A.II
155,022	*R*	155022R	y	87	y	core	y	y	A.II
155,022	*W*	155022W	y	87	y	core	y		Fragment
155,023	*G**	155023g	y	88	y	core	y		A.II
155,023	*R*	155023R	y	88	y	core	y		A.II
155,023	*W*	155023W	y	88	y	core	y		A.II
155,027	*G**	155027G	y	89	y	core	y	y	A.II
155,027	*R*	155027R	y	89	y	core	y	y	A.II
167,004	*R*	167004	y	103	y	core	y		B.I
167,015	*G**	167015G	y	104	y	core	y	y	B.I
167,015	*R*	167015R	y	104	y	core	y	y	B.I
167,015	*X*	167015X	y	104	y	core	y	y	B.I
167,017	*G**	167017	y	105	y	core	y		B.I
167,022	*Eta*	167022Eta		106	y	core	y	y	B.I
167,022	*G**	167022G	y	106	y	core	y	y	B.I
167,022	*W*	167022W	y	106	y	core	y	y	B.I
167,022	*X*	167022X	y	106	y	core	y	y	B.I
167,027	*G**	167027	y	107	y	core	y		B.I
167,030	*G**	167030G	y	108	y	core	y	y	B.I
167,030	*R*	167030R	y	108	y	core	y	y	B.I
167,030	*W*	167030W	y	108	y	core	y	y	B.I
167,032	*G**	167032G	y	109	y	core	y	y	B.I
167,032	*R*	167032R	y	109	y	core	y	y	B.I
167,032	*X*	167032X	y	109	y	core	y	y	B.I
167,034	*G**	167034	y	110	y	core	y		B.I
167,037	*R*	167037R	y	111	y	core	y	y	B.I
167,037	*X*	167037X	y	111	y	core	y	y	B.I
167,043	*G**	167043G	y	112	y	core	y	y	B.I

BEdT No.	Ms	TMD ID	Aubrey	Genn.No	Halperin	Steel	Van der Werf	Vanin	Ch. III Periods
167,043	*R*	167043R	y	112	y	core	y	y	B.I
167,043	*W*	167043W	y	112	y	core	y	y	B.I
167,052	*G**	167052G	y	113	y	core	y	y	B.I
167,052	*R*	167052R	y	113	y	core	y	y	B.I
167,052	*X*	167052X	y	113	y	core	y	y	B.I
167,053	*R*	167053R	y	114	y	core	y		B.I
167,053	*X*	167053X	y	114	y	core	y		B.I
167,056	*G**	167056G	y	115	y	core	y	y	B.I
167,056	*X*	167056X	y	115	y	core	y	y	B.I
167,059	*G**	167059G	y	116	y	core	y		B.I
167,059	*R*	167059R	y	116	y	core	y		B.I
183,010	*Chig*	183010		7	y	core	y		Fragment
189,005	*R*	189005							Fragment
194,003	*G**	194003	y	163	y	core	y	y	A.II
194,006	*G**	194006	y	164	y	core	y	y	A.II
194,008	*W*	194008	y	165	y	core	y	y	A.II
194,019	*G**	194019	y	166	y	core	y	y	A.II
202,008	*R*	202008	y	167	y	core	y		B.II
205,005	*W*	205005	y	184		core	excluded		C.I
223,001	*W*	223001	y	168	y	core	y		B.II
223,003	*W*	223003	y	169	y	core	y		B.II
234,016	*G**	234016G	y	94	y	core	y		B.I
234,016	*R*	234016R	y	94	y	core	y		B.I
242,045	*R*	242045	y	56	y	core	y	y	B.I
242,051	*R*	242051	y	57	y	core	y	y	B.I
242,064	*R*	242064	y	58	y	core	y	y	B.I
242,069	*R*	242069	y	59	y	core	y	y	B.I
244,001a	*W*	244,001a	y	259	y	core	excluded		C.I

BEdT No.	Ms	TMD ID	Aubrey	Genn.No	Halperin	Steel	Van der Werf	Vanin	Ch. III Periods
248,001	*R*	248001	y	193	y	core	y	y	C.II
248,002	*R*	248002	y	194	y	core	y		C.II
248,005	*R*	248005	y	195	y	core	y	y	C.II
248,006	*R*	248006	y	196	y	core	y		C.II
248,007	*R*	248007	y	197	y	core	y		C.II
248,008	*R*	248008	y	198	y	core	y	y	C.II
248,010	*R*	248010	y	199	y	core	y		C.II
248,012	*R*	248012	y	200	y	core	y		C.II
248,013	*R*	248013	y	201	y	core	y	y	C.II
248,018	*R*	248018	y	202	y	core	y		C.II
248,019	*R*	248019	y	203	y	core	y		C.II
248,021	*R*	248021	y	204	y	core	y	y	C.II
248,023	*R*	248023	y	205	y	core	y		C.II
248,024	*R*	248024	y	206	y	core	y		C.II
248,026	*R*	248026	y	207	y	core	y	y	C.II
248,027	*R*	248027	y	208	y	core	y		C.II
248,029	*R*	248029	y	209	y	core	y		C.II
248,030	*R*	248030	y	210	y	core	y	y	C.II
248,031	*R*	248031	y	211	y	core	y		C.II
248,033	*R*	248033	y	212	y	core	y		C.II
248,044	*R*	248044	y	213	y	core	y	y	C.II
248,045	*R*	248045	y	214	y	core	y		C.II
248,046	*R*	248046	y	215	y	core	y		C.II
248,048	*R*	248048	y	216	y	core	y	y	C.II
248,052	*R*	248052	y	217	y	core	y		C.II
248,053	*R*	248053	y	218	y	core	y		C.II
248,055	*R*	248055	y	219	y	core	y	y	C.II
248,056	*R*	248056	y	220	y	core	y		C.II

BEdT No.	Ms	TMD ID	Aubrey	Genn.No	Halperin	Steel	Van der Werf	Vanin	Ch. III Periods
248,057	*R*	248057	y	221	y	core	y		Fragment
248,058	*R*	248058	y	222	y	core	y	y	C.II
248,060	*R*	248060	y	223	y	core	y		C.II
248,061	*R*	248061	y	224	y	core	y		C.II
248,062	*R*	248062	y	225	y	core	y	y	C.II
248,063	*R*	248063	y	226	y	core	y		C.II
248,065	*R*	248065	y	227	y	core	y		C.II
248,066	*R*	248066	y	228	y	core	y	y	C.II
248,067	*R*	248067	y	229	y	core	y		C.II
248,068	*R*	248068	y	230	y	core	y		C.II
248,069	*R*	248069	y	231	y	core	y	y	C.II
248,071	*R*	248071	y	232	y	core	y		C.II
248,078	*R*	248078	y	233	y	core	y		C.II
248,079	*R*	248079	y	234	y	core	y	y	C.II
248,080	*R*	248080	y	235	y	core	y		C.II
248,082	*R*	248082	y	236	y	core	y		C.II
248,083	*R*	248083	y	237	y	core	y	y	C.II
248,085	*R*	248085	y	238	y	core	y		C.II
248,087	*R*	248087	y	239	y	core	y		C.II
248,089	*R*	248089	y	240	y	core	y		C.II
262,002	*R*	262002R	y	12	y	core	y	y	A.I
262,002	*W*	262002W	y	12	y	core	y	y	A.I
262,002	*X*	262002X	y	12	y	core	y	y	A.I
262,003	*R*	262003	y	13	y	core	y	y	A.I
262,005	*R*	262005	y	14	y	core	y	y	A.I
262,006	*R*	262006	y	15	y	core	y	y	A.I
273,001	*W*	273001	y	48		core	y		B.I
293,013	*W*	293013	y	8	y	core	y	y	A.I

BEdT No.	Ms	TMD ID	Aubrey	Genn.No	Halperin	Steel	Van der Werf	Vanin	Ch. III Periods
293,018	*R*	293018	y	9	y	core	y	y	A.I
293,030	*R*	293030	y	10	y	core	y	y	A.I
293,035	*W*	293035	y	11	y	core	y	y	A.I
297,004	*Esc*	297004Esc		242	y	core	y		C.II
297,004	*Eug*	297004Eug		242	y	core	y		C.II
297,004	*Hoh*	297004Hoh		242	y	core	y		C.II
297,004	*Len*	297004Len		242	y	core	y		C.II
305,006	*R*	305006	y	92	y	core	y		B.II
305,010	*R*	305010	y	93	y	core	y		B.II
323,004	*W*	323004	y	35	y	core	y		A.I
323,015	*R*	323015R	y	36	y	core	y		A.I
323,015	*X*	323015X	y	36	y	core	y		A.I
335,007	*R*	335007	y	185	y	core	y		C.I
335,049	*R*	335049	y	186	y	core	y		C.I
335,067	*R*	335067	y	187	y	core	y		C.I
355,005	*G**	355005	y	55	y	core	y		B.II
364,004	*G**	364004G	y	60	y	core	y	y	B.II
364,004	*R*	364004R	y	60	y	core	y	y	B.II
364,004	*X*	364004X	y	60	y	core	y	y	B.II
364,007	*R*	364007	y	61	y	core	y		B.II
364,011	*G*	364011G	y	62	y	core	y	y	B.II
364,011	*R*	364011R	y	62	y	core	y	y	B.II
364,011	*X*	364011X	y	62	y	core	y	y	B.II
364,024	*R*	364024	y	63	y	core	y		B.II
364,030	*R*	364030	y	64	y	core	y		B.II
364,031	*R*	364031	y	65	y	core	y		B.II
364,036	*R*	364036	y	66	y	core	y	y	B.II
364,037	*G**	364037	y	67	y	core	y		B.II

BEdT No.	Ms	TMD ID	Aubrey	Genn.No	Halperin	Steel	Van der Werf	Vanin	Ch. III Periods
364,039	*G**	364039G	y	68	y	core	y	y	B.II
364,039	*R*	364039R	y	68	y	core	y	y	B.II
364,039	*W*	364039W	y	68	y	core	y	y	B.II
364,040	*G**	364040	y	69	y	core	y	y	B.II
364,042	*R*	364042	y	70	y	core	y		B.II
364,049	*W*	364049	y	71	y	core	y	y	B.II
366,002	*R*	366002	y	117	y	core	y		B.II
366,003	*G**	366003	y	118	y	core	y	y	B.II
366,006	*G*	366006	y	119	y	core	y	y	B.II
366,009	*G**	366009G	y	120	y	core	y	y	B.II
366,009	*R*	366009R	y	120	y	core	y	y	B.II
366,011	*G**	366011	y	121	y	core	y		B.II
366,012	*G**	366012G	y	122	y	core	y	y	B.II
366,012	*X*	366012X	y	122	y	core	y	y	B.II
366,013	*G**	366013	y	123	y	core	y		B.II
366,014	*G**	366014	y	124	y	core	y	y	B.II
366,015	*G**	366015	y	125	y	core	y		B.II
366,019	*R*	366019	y	126	y	core	y	y	B.II
366,020	*R*	366020	y	127	y	core	y		B.II
366,021	*G**	366021	y	128	y	core	y	y	B.II
366,022	*G**	366022	y	129	y	core	y		B.II
366,026	*G***	366026	y	130	y	core	y	y	B.II
366,029	*G**	366029	y	131	y	core	y		B.II
366,031	*G**	366031	y	132	y	core	y	y	B.II
366,033	*G*	366033	y	133	y	core	y		B.II
370,009	*G**	370009	y	160	y	core	y		B.II
370,013	*G**	370013	y	161	y	core	y		B.II
370,014	*G**	370014G	y	162	y	core	y		B.II

BEdT No.	Ms	TMD ID	Aubrey	Genn.No	Halperin	Steel	Van der Werf	Vanin	Ch. III Periods
370,014	*X*	370014X	y	162	y	core	y		Fragment
372,003	*Cangé*	372003Cange		95	y	core	y		C.I
372,003	*X*	372003X	y	95	y	core	y		C.I
375,014	*W*	375014	y	73	y	core	y	y	C.I
375,016	*G**	375016	y	74	y	core	y	y	C.I
375,019	*G**	375019	y	75	y	core	y	y	C.I
375,027	*X*	375027X	y	75	y	core	y	y	C.I
375,027	*R*	375027R	y	76	y	core	y	y	C.I
379,002	*R*	379002	y	241	y	core	y		C.I
389,036	*X*	389036	y	37	y	core	y		A.I
392,002	*R*	392002	y	96	y	core	y	y	B.II
392,003	*R*	392003	y	97	y	core	y	y	B.II
392,009	*R*	392009	y	98	y	core	y	y	B.II
392,013	*R*	392013	y	99	y	core	y	y	B.II
392,018	*R*	392018	y	100	y	core	y	y	B.II
392,024	*R*	392024	y	101	y	core	y	y	B.II
392,026	*R*	392026	y	188	y	core	y		B.II
392,028	*R*	392028	y	102	y	core	y	y	B.II
404,004	*W*	404004	y	135	y	core	y		A.II
404,011	*W*	404011	y	136	y	core	y		A.II
406,002	*G**	406002G	y	137	y	core	y	y	C.I
406,002	*R*	406002R	y	137	y	core	y	y	C.I
406,007	*G**	406007G	y	138	y	core	y	y	C.I
406,007	*R*	406007R	y	138	y	core	y	y	C.I
406,008	*R*	406008	y	139	y	core	y		C.I
406,009	*R*	406009	y	140	y	core	y	y	C.I
406,012	*R*	406012	y	141	y	core	y		C.I
406,013	*G*	406013G	y	142	y	core	y	y	C.I

BEdT No.	Ms	TMD ID	Aubrey	Genn.No	Halperin	Steel	Van der Werf	Vanin	Ch. III Periods
406,013	*R*	406013R	y	142	y	core	y	y	C.I
406,014	*R*	406014	y	143	y	core	y		C.I
406,015	*R*	406015	y	144	y	core	y	y	C.I
406,018	*R*	406018	y	145	y	core	y		C.I
406,020	*G**	406020G	y	146	y	core	y	y	C.I
406,020	*R*	406020R	y	146	y	core	y	y	C.I
406,021	*R*	406021	y	147	y	core	y		C.I
406,022	*R*	406022	y	148	y	core	y	y	C.I
406,023	*R*	406023	y	149	y	core	y		C.I
406,024	*R*	406024	y	150	y	core	y	y	C.I
406,028	*R*	406028	y	151	y	core	y		C.I
406,031	*R*	406031	y	152	y	core	y	y	C.I
406,036	*R*	406036	y	153	y	core	y		C.I
406,039	*R*	406039	y	154	y	core	y	y	C.I
406,040	*R*	406040	y	155	y	core	y		C.I
406,042	*R*	406042	y	156	y	core	y	y	C.I
406,044	*R*	406044	y	157	y	core	y		C.I
406,047	*R*	406047	y	158	y	core	y	y	C.I
420,002	*Cangé*	420002Cange							A.II
420,002	*TrouvK 392*	420002TrK							A.II
420,002	*TrouvN 392*	420002TrN							A.II
420,002	*TrouvX 252r*	420002TrX							A.II
421,001	*G**	421001G	y	170	y	core	y	y	A.I
421,001	*W*	421001W	y	170	y	core	y	y	A.I
421,002	*G**	421002G	y	171	y	core	y	y	A.I
421,002	*W*	421002W	y	171	y	core	y	y	A.I
421,002	*X*	421002X	y	171	y	core	y	y	A.I
421,003	*X*	421003	y	172	y	core	y	y	A.I

BEdT No.	Ms	TMD ID	Aubrey	Genn.No	Halperin	Steel	Van der Werf	Vanin	Ch. III Periods
421,006	*W*	421006							Fragment
421,010	*W*	421010	y	173	y	core	y	y	A.I
450,003	*R*	450003	y	134	y	core	y		B.I
457,003	*G**	457003	y	174	y	core	y		C.I
457,026	*G*	457026	y	175	y	core	y		C.I
457,040	*G**	457040	y	176	y	core	y		C.I
461,008b	*Chig*			265	y	satellite	excluded		
461,008c	*Chig*			266	y	satellite	excluded		
461,009	*W*	461009	y	243	y	core	y		
461,012	*X*	461012		244	y	core	excluded		
461,013	*W*	461013	y	245	y	core	y		
461,020a	*W*	461020a	y	257	y	core	excluded		
461,020b	*SJA*	461020b		246	y	satellite	excluded		
461,027b	*SJA*	461027b		258	y	satellite	excluded		
461,037	*W*	461037	y	282		core	excluded		
461,042a	*Chig*			247	y		excluded		
461,042b	*Chig*			267	y	satellite	excluded		
461,042c	*Chig*			268	y	satellite	excluded		
461,046a	*Lat1139*			3		satellite			
461,067a	*W*	461067a				core			
461,073a	*Chig*			248	y		excluded		
461,084a	*Chig*			269	y	satellite	excluded		
461,092	*W*	461092	y	260	y	core	excluded		
461,102	*W*	461102	y	249	y	core	y		
461,102a	*Chig*			250	y		excluded		
461,114a	*Mo120*			6		satellite			
461,121a	*Chig*			270	y	satellite	excluded		
461,122	*Delta*	461122delta	y	281		core	excluded		Fragment

BEdT No.	Ms	TMD ID	Aubrey	Genn.No	Halperin	Steel	Van der Werf	Vanin	Ch. III Periods
461,122	*W*	461122W	y	281		core	excluded		
461,124	*Delta*	461124delta	y	280		core	excluded		
461,124	*W*	461124W	y	280		core	excluded		
461,141a	*Chig*			271	y	satellite	excluded		
461,144a	*Chig*			251	y		excluded		
461,146	*W*	461146		284		core	excluded		
461,148	*X*	461148		252	y	core	excluded		
461,148a	*Mo196*			285		satellite	excluded		
461,148b	*Cdp (BNF25532)*					satellite			
461,148b	*Mo196*					satellite			
461,150	*W*	461150	y	253	y	core	y		
461,152	*W*	461152	y	254	y	core	y		
461,160a	*Chig*			272	y	satellite	excluded		
461,164b	*Lat1139*					satellite			
461,165a	*Chig*			273	y	satellite	excluded		
461,170a	*Mo196*			286		satellite	excluded		
461,170a	*T181*			286		satellite	excluded		
461,170a	*Naf* (Steel *CL*)			286		satellite	excluded		
461,181a	*Lat1139*			2		satellite			
461,192a	*LaVal/n*	461192a		264	y	satellite			
461,196	*W*	461196	y	261	y	core	excluded		
461,197	*W*	461197	y	72	y	core			
461,199a	*Mad*			263	y	satellite	excluded		
461,215a	*Chig*			274	y	satellite	excluded		
461,215b*	*Chig*	461215b*		275	y	satellite	excluded		
461,215c	*SJA*	461215c		255	y	satellite	excluded		Fragment
461,215c*	*Chig*			276	y	satellite	y		

BEdT No.	Ms	TMD ID	Aubrey	Genn.No	Halperin	Steel	Van der Werf	Vanin	Ch. III Periods
461,218a	*Chig*	461218a		277	y	satellite	y		
461,219a	*Chig*			278	y	satellite	excluded		
461,225a	*Chig*			279	y	satellite	excluded		
461,230	*W*	461230	y	262	y	core	excluded		
461,240a	*CdP*	461240a							Refrain
461,247a	*Chig*			256	y		excluded		
461,251b	*SJA*	461251b				satellite	excluded		Fragment
El cor ai un’	*W2*			283		satellite	excluded		
mc_106,017				298	y				
mc_155,006				296	y				
mc_183,003				287	y				
mc_293,029				288	y				
mc_293,032				289	y				
mc_293,033				290	y				
mc_304,001				300	y				
mc_305,016				297	y				
mc_355,010				295	y				
mc_437,010				299	y				
mc_461,179a				302	y				
mc_70,044				291	y				
mc_80,001				292	y				
mc_80,009				293	y				
mc_80,019				294	y				
Molt i fetz	*Fb* (Steel *Xa*)					satellite			

Appendix C:

Description of the Melody Analysis Tool

This appendix includes a list of all of the features extracted from the encoded melodies by the Melody Analysis Tool. A table of these features themselves generated by the Melody Analysis Tool from the encoded melodies in the TMD is available in the database with other dissertation resources.

Features Extracted by the Melody Analysis Tool

Pitch:

- First
- Last
- Highest
- Lowest
- Range as pitches (in Volpiano)
- Boundary notes (first, lowest, highest and last on staff with treble clef, in Volpiano)
- Cadential pitches (last 3)
- Total number of pitches in melody
- Count of each pitch in each melody
- List of all unique pitches in each melody
- Three most frequently appearing pitches
- Version of melody with pitches/neumes separated by white space instead of hyphens
- Melody as string of pitches with phrases marked

Interval:

- First interval
- First two intervals
- Last interval
- Cadential intervals (last 3)
- Range as interval (number)
- Range as interval (interval number with quality)
- Range above final
- Range below final
- Interval profile (with quality and direction of each interval)
- List of each unique interval in melody
- Total number of intervals in each melody
- Total of each interval per melody (divided by quality and direction)
- Melodies as directional strings (ascending or descending motion)

Neumes:

- Total number of neumes in melody
- Count of each neume-length per melody (by number of pitches per neume)
- Average number of pitches per neume
- Melody as a string of neume lengths in melody order

Appendix D: Catalog of Melismas in the Melodies of Guiraut Riquier

This appendix includes a catalog of the 105 unique melismas (neumes containing four or more pitches over a syllable) in the melodies of Guiraut Riquier. The melisma is divided into two parts: stepwise melismas and melismas with an internal leap (all of his melismas with a leap do so by an interval of a third). Within these two sections, the melismas are organized first by length (four to eleven pitches) and then alphabetically. The table includes the number of occurrences of each melisma in Riquier's output as well as the total number of melodies each melisma appears in. For context, the table below shows the number of melismas of each length found in his melodies, as well as the total number of occurrences of and number of melodies with that length melisma.

Stepwise Melismas

Melisma Length	No. of Melismas	No. of Occurrences	No. of Melodies
4	45	254	174
5	32	107	68
6	17	37	29
7	6	9	5
8	4	7	5
11	1	2	1

Melismas with Leaps (Third)

Melisma Length	No. of Melismas	No. of Occurrences	No. of Melodies
4	3	4	4
5	2	2	2
6	1	1	1
7	1	1	1

Stepwise Melismas

Melisma (Volpiano)	Melisma	Length	No. of Occurrences	No. of Melodies
dcde	d’c’d’e’	4	10	7
dedc	d’e’d’c’	4	2	2
defe	d’e’f’e’	4	2	1
edcd	e’d’c’d’	4	1	1
edef	e’d’e’f’	4	9	4
efed	e’f’e’d’	4	18	9
fedc	f’e’d’c’	4	26	18
fede	f’e’d’e’	4	13	8
fefg	f’e’f’g’	4	9	3
fghg	f’g’a’g’	4	4	3
fghj	f’g’a’b’	4	2	2
gfed	g’f’e’d’	4	14	9
gfef	g’f’e’f’	4	5	3
gfgh	g’f’g’a’	4	5	4
ggfe	g’g’f’e’	4	2	1
ghgf	g’a’g’f’	4	18	12
ghjh	g’a’b’a’	4	2	1
hgfe	a’g’f’e’	4	13	12
hgfg	a’g’f’g’	4	7	5
hghij	a’g’a’b-flat’	4	1	1
hghj	a’g’a’b’	4	17	12
hijhg	a’b’-flata’g’	4	1	1
hjhg	a’b’a’g’	4	30	19
hjkj	a’b’c’’b’	4	1	1
ijhgf	b’-flata’g’f’	4	1	1
ijhgh	b-flat’a’g’a’	4	5	4
jhgf	b’a’g’f’	4	2	2
jhgh	b’a’g’a’	4	3	2
jkjh	b’c’’b’a’	4	2	2
kjhg	c’’b’a’g’	4	3	3
kjhj	c’’b’a’b’	4	5	3
kjjh	c’’b’b’a’	4	1	1
kjkl	c’’b’c’’d’’	4	3	3
klkij	c’’d’’c’’b’-flat	4	1	1
klkj	c’’d’’c’’b’	4	5	4
lkkj	d’’c’’c’’b’	4	1	1

Melisma (Volpiano)	Melisma	Length	No. of Occurrences	No. of Melodies
lklm	d’’c’’d’’e’’	4	2	2
mlkk	e’’d’’c’’c’’	4	2	1
mnml	e’’f’’e’’d’’	4	1	1
mnon	e’’f’’g’’f’’	4	1	1
nmlk	f’’e’’d’’c’’	4	1	1
nmlm	f’’e’’d’’e’’	4	3	2
dcdef	d’c’d’e’f’	5	2	1
defed	d’e’f’e’d’	5	2	1
ededc	e’d’e’d’c’	5	1	1
efedc	e’f’e’d’c’	5	3	2
fedcd	f’e’d’c’d’	5	8	5
feddc	f’e’d’d’c’	5	2	1
feedc	f’e’e’d’c’	5	2	1
feede	f’e’e’d’e’	5	1	1
fefgf	f’e’f’g’f’	5	6	3
ffgfe	f’f’g’f’e’	5	1	1
gffed	g’f’f’e’d’	5	5	2
ggffe	g’g’f’f’e’	5	2	1
ghgfe	g’a’g’f’e’	5	4	4
ghijhg	g’a’b’-flata’g’	5	3	2
ghjhg	g’a’b’a’g’	5	9	6
hgfed	a’g’f’e’d’	5	1	1
hgfef	a’g’f’e’f’	5	4	3
hghgf	a’g’a’g’f’	5	14	5
hghjh	a’g’a’b’a’	5	13	6
hjhgf	a’b’a’g’f’	5	1	1
hjhgh	a’b’a’g’a’	5	6	6
hjkjh	a’b’c’’b’a’	5	1	1
ijhijhg	b’-flata’b’-flata’g’	5	1	1
kjhgf	c’’b’a’g’f’	5	2	2
kjhgh	c’’b’a’g’a’	5	2	2
kjjhg	c’’b’b’a’g’	5	3	2
lkjkl	d’’c’’b’c’’d’’	5	4	3
lmllk	d’’e’’d’’d’’c’’	5	1	1
onnml	g’’f’’f’’e’’d’’	5	2	1
onopo	g’’f’’g’’a’’g’’	5	1	1
feddcd	f’e’d’d’c’d’	6	1	1
feedcd	f’e’e’d’c’d’	6	1	1

Melisma (Volpiano)	Melisma	Length	No. of Occurrences	No. of Melodies
fghijhg	f’g’a’b’-flata’g’	6	1	1
fghjhg	f’g’a’b’a’g’	6	4	3
gffedc	g’f’f’e’d’c’	6	2	2
ghgfed	g’a’g’f’e’d’	6	1	1
ghijhgh	g’a’b’-flata’g’a’	6	1	1
ghjhgh	g’a’b’a’g’a’	6	6	5
hghjhg	a’g’a’b’a’g’	6	10	7
ijhjhgh	b’-flata’b’a’g’a’	6	1	1
jhjhgh	b’a’b’a’g’a’	6	1	1
kjjhgf	c’’b’b’a’g’f’	6	1	1
kjjhgh	c’’b’b’a’g’a’	6	3	1
kkjjhg	c’’c’’b’b’a’g’	6	1	1
lkkjhg	d’’c’’c’’b’a’g’	6	1	1
mnonml	e’’f’’g’’f’’e’’d’’	6	2	1
defghgf	d’e’f’g’a’g’f’	7	1	1
fghghgf	f’g’a’g’a’g’f’	7	1	1
fghjhgh	f’g’a’b’a’g’a’	7	5	1
kklkjhg	c’’c’’d’’c’’b’a’g’	7	1	1
llkkjhg	d’’d’’c’’c’’b’a’g’	7	1	1
gfghjhgh	g’f’g’a’b’a’g’a’	8	3	2
hijhggfef	a’b’-flata’g’g’f’e’f’	8	2	1
jklkkjhj	b’c’’d’’c’’c’’b’a’b’	8	1	1
kjhhgfgh	c’’b’a’a’g’f’g’a’	8	1	1
hijhghgfedcd	a’b’-flata’g’a’g’f’e’d’c’d’	11	2	1

Melismas with Leaps (3rd)

Melisma (Volpiano)	Melisma	Length	No. of Occurrences	No. of Melodies	Leap Interval
dcdf	d’c’d’f’	4	2	2	3rd
ghge	g’a’g’e’	4	1	1	3rd
mnmk	e’’f’’e’’c’’	4	1	1	3rd
edced	e’d’c’e’d’	5	1	1	3rd
fghge	f’g’a’g’e’	5	1	1	3rd
hgfhgf	a’g’f’a’g’f’	6	1	1	3rd
ghijhghf	g’a’b’-flata’g’a’f’	7	1	1	3rd

Katie Elizabeth Chapman

Education

2008-2020	Indiana University, Bloomington, PhD, Musicology Minor Field: Ethnomusicology Dissertation: "Digital Approaches to Troubadour Song" Completed: January 2020 Committee: Giuliano Di Bacco (chair), Giovanni Zanovello, Dan Melamed, Elizabeth Hebbard
2004-2008	Furman University, Bachelor of Music in Music Theory, magna cum laude Secondary Major: History

Academic Honors & Grants

May 2019	Bursary for Music Encoding Conference (Vienna, Austria) Peter Burkholder and Doug McKinney Musicology Fund (travel to MEC 2019)
Summer 2017	AMS M. Elizabeth C. Bartlet Travel Grant (Dissertation Research in France)
Summer 2017	Bursary for Digital Humanities at Oxford Summer School (Digital Musicology Strand)
May 2017	Clifford Flanigan Memorial Travel Grant (to Present at 2017 Medieval Congress)
Spring 2017	Grant-in-Aid of Doctoral Research (Indiana University)
November 2016	Beinecke Rare Book & Manuscript Library Digital Manuscript Studies Travel Award
Fall 2015	Grant-in-Aid of Doctoral Research (Indiana University)
Fall 2015	Travel Award from the A. Peter Brown Fund (Troubadour Working Group Meeting)
Summer 2013	Travel Award from the A. Peter Brown Fund (Dissertation Research Trip)

Fellowships

Fall 2016-Spring 2017	Dissertation-Year Fellowship, Indiana University, Musicology Department
2008-2012	Fellowship, Jacobs School of Music at Indiana University, Department of Musicology

Teaching Experience: Instructor of Record

Indiana University:

Summer 2016	Instructor for M501: Proseminar in Music History and Literature Topics: The Soloist (1600-1750); Magic in the 19th Century; Political Song (13th-21st centuries)
Fall 2014	Instructor for M541: Graduate Music History Review to 1750
Fall 2013	Instructor for M542: Graduate Music History Review II (post 1750)
Fall 2012	Instructor for M541: Graduate Music History Review to 1750

Teaching Experience: Assisting

Fall 2010-Spring 2012	Indiana University: Associate Instructor for M401 and M402: Undergraduate Music History Surveys
Fall 2007	Furman University: Teaching Assistant for "Studies in Music: History, Philosophy, and Practice," Undergraduate Music History Survey

Digital Humanities Experience

2019	The Lilly Library from A to Z (companion site and 3D models for Darlene J. Sadlier, *The Lilly A to Z: Intriguing Objects in a World-Class Collection* (Bloomington: Indiana University Press, 2019). https://lillyaz.indiana.edu/
Fall 2017-Fall 2019	Graduate Assistant for Cyberinfrastructure for Digital Humanities Group (Indiana University, Bloomington)
Summer 2017	Digital Humanities at Oxford Summer School: Digital Musicology Strand

November 2016	Digital Medieval Manuscripts Fragments Workshop (Yale University)
2016-2018	HASTAC Scholar
February 2015 -present	Troubadour Melodies Database (Dissertation Companion Site) www.troubadourmelodies.org
February 2014	Live-Blog for P. Q. Phan's *The Tale of Lady Thị Kính* (Opera Production/Premiere at Indiana University, Bloomington)
July 2012- March 2018	Variations/MCO Sound Digitizing Assistant, William & Gayle Cook Music Library (Indiana University, Bloomington)

Presentations

2019	November 1	Panelist: "Digital Musicology: Dialogue, Demonstration, Demystification." American Musicological Society Annual Meeting, Boston.
	May 28	Poster, "Encoding the Troubadours." Music Encoding Conference 2019, Vienna, Austria.
2017	July 13	"Biblical and Religious References in Troubadour Song Connected to the Albigensian Crusade." XII Congrès de l'Association Internationale d'Études Occitanes, Albi, France.
	May 12	"The Resonance of Borrowed Melody in Troubadour Song." International Congress on Medieval Studies, Kalamazoo, MI.
	March 22	"Encoding Song in the Troubadour Melodies Database." Digital Library Brown Bag Series, Indiana University, Bloomington. http://hdl.handle.net/2022/21337
	March 2	Panelist: "Reframing 'Traditional' Sources and Scholarship in Musicology." Digitorium, University of Alabama, Tuscaloosa.

Languages

French	Reading proficient, limited spoken
Italian	Reading proficient, limited spoken
German	Reading proficient

Additional Skills

Working Knowledge of:

Languages: CSS, HTML, PHP, TEI, XML

Software: Microsoft Access, ArcGIS, Carto, Drupal, Excel, Gephi, InDesign, Illustrator, Lightroom, Meshlab, Omeka, Oxygen, Photoscan/Metashape, Photoshop, PHPMyAdmin, Reality Capture, Scalar, Wordpress

Basic Working Knowledge of:

Languages: Javascript, Python, R

Software: MySQL Workbench, RStudio

Professional Organization Membership

American Musicological Society
American Musicological Society- Midwest Chapter
Association Internationale d'Études Occitanes
Humanities, Arts, Science, and Technology Alliance and Collaboratory (HASTAC)
International Courtly Literature Society
Medieval Academy of America
Société Guilhem IX